CROSS REFERENCE FILE FORM

9.666E

SEE LETTER TO - KRShipley / W. J. Keys

SEE LETTER FROM - V. C. Larson

DATED - December 29, 1967

FILED - 9.666

SUBJECT Annual Report

Esso

IMPERIAL OIL LIMITED

339 - 50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

PRODUCTION RESEARCH AND TECHNICAL SERVICE LABORATORY

WESTERN REGION PRODUCING DEPARTMENT

V. C. LARSON
MANAGER

No. 699

December 15, 1967

Mr. K.R. Shipley,
Manager,
Pipeline Division,
Transportation & Supply Dept.,
Imperial Oil Limited,
111 St. Clair Avenue, W.,
TORONTO,
Ontario.

P/L DIVISION			
FILE No. 9.666E			
DEC 20 1967			
	NOTE	ACT	INITIAL
KRS	✓		KRS
CC			
OMK			
RAP			
LDA			
BMB			
CJD			
RDC			
CVH			
WJK	✓		WJK
DATE ANS'D 2452			

Attention: Mr. W. S. Keys

Dear Sir:

Re: Arctic Test Pipeline - Project No. 483
Stress Analysis.

Attached are four copies of Lab. Report No. L-79267 discussing observations resulting from the recent survey of the test line.

The pipeline instrumentation appears to be functioning very well although some difficulties are being encountered as a result of faulty moisture seals. The majority of gauges and thermistors are, however, functioning and arrangements have been completed with government personnel for the collecting of additional data.

Details of stress concentrations will be presented as soon as sufficient data has been received and processed.

Yours very truly,

VCLarson

V. C. Larson

CD/Psg
attach.

cc: J.E. Lyle
R.A. Hemstock

Laboratory Report No. L-79267

Arctic Pipeline Project No. 483
Observations of October 26, 1967

Reference: Lab. Rept. Nos. L-36967 and L-36767

Background:

Construction of the test line was completed in August 1967, and details are reported in Lab. Rept. No. L-63767.

The purpose of the present report is to record observations made during the October 26, 1967 precise survey of the line.

Details:

Terrain - the ground was covered to a depth of about 6 inches with snow which had begun to fall in mid September.

The cat trails and terrain upset during construction showed extensive ice formation. This indicates that melting and water accumulation along the right-of-way continued following construction.

Grass seed had been sown in the heavily disturbed region north of the road crossing prior to freeze-up.

Mounding - the mounding had frozen to a very great extent but evidence of mud was found along the 10 inch section running downhill to the creek.

The wood-chip section has not compacted noticeably and appears to be staying in position. Rain had provided enough moisture to cause the top 2 inches of chips to freeze. The remaining depth of chips was not frozen.

The road crossing remains in excellent condition. No significant settling has taken place.

Extensive ice formation was observed along the 16 inch line but the backfill does not appear to have compacted. The entire line appears to be frozen in mud with only the top surface of the line exposed beneath the mounding.

Instrumentation - A set of readings on all of the strain gauges and thermistors was taken. This opportunity was used as a demonstration for the technicians of the Federal Government who will repeat the readings twice monthly. The necessary data sheets, spare parts and instructions were provided for their use.

Terminal boxes were all found as installed and dry. Evidence of drying compound color change in a number of the boxes indicates that this material is successfully drying the terminal connector environment.

No additional physical damage to the installation has been experienced, although as pointed out in the previous report, several thermistors show evidence of short circuits. Water or condensation leakage is also now suspected in several strain gauge sets.

Snow accumulates on the terminal base lids but in melting, the water runs off the back of the box as desired. No problems of accessibility were encountered and no evidence of tampering was found.

The strain gauges located in the water at the North shore station 3 have not been upset by ice but they are only 1 or 2 inches below surface. Gauges on the south shore Station 4 are submerged and operating well.

Conclusions:

Temperature Data

1. The above surface line was heated to about 10 to 15^{o} over ambient conditions of +5^{o}F in still air.

2. Snow cover on the surface line also appears to hold temperatures slightly above ambient although some heat conducted from bare-elevated line may be a factor.

3. Almost half of the bottom surface thermistors do not appear to be functioning and their location, essentially under water, does not seem to have been adequately moisture-proofed.

4. The wood chip mounding is as effective as the moss cover in maintaining line temperature at 32^{o} (5^{o} ambient).

Mounding generally appears to be successful.

Strain Data:

1. Moisture proofing of the strain gauges appears to have been quite good although some indications of leakage is beginning to show on about 9 gauges. The majority of these could be repaired next summer if future data confirms initial indications.

2. Strain data generally suggests the following:

a) the pipe anchors at Stations 1 and 11 have been placed well and seem to have settled slightly.

b) stress levels in the exposed surface line are very low suggesting line movement to cause stress relaxation.

c) the line appears to be anchored by the frozen mud in the shallow burial regions of Stations 2 and 3 causing stress accumulation in this area to 40,000 psi. Some gauge error due to water or condensation is considered possible here.

d) stress levels at the shore and ice level on each side of the lake are below 15,000 psi.

e) as anticipated, high stress levels are also evident at the elbow fitting of the 6 inch to 16 inch transition where the larger diameter pipe is well anchored in the frozen mud. Any stress caused by expansion will be largely borne by the elbow (28,000 psi tension on the outer elbow well, longitudinal).

f) very high stress levels are indicated at the 16" weld cap at Station 7. Since this also was an extremely wet area some moisture leakage may have taken place. Stresses to yield have been measured.

g) Stress levels at each end of the 16 inch line are about 2000 psi.

h) Higher stress, 20,000 psi, is measured on the 10 inch line near the anchored 16 inch pipe but the remainder of the line shows little high stress concentration.

i) No significant differences in stress concentration are evident between the various types and depths of mounding material. A trend to higher stresses is however, evident in areas where heavy melting and water accumulation resulted from construction operations.

C. DUNCAN.

KRS

Jan 11 '67

Arctic Pipe Line Research #483

Expenditure

1966 $400

1967 - revised budget 83,500

will spend 87,000

budget over run $3,500

1968 budget $35,000

cover work

1) Rheology

2) Continue soil temperature survey

3) Test pipe line section

a) Readings - temperature & strain

b) Check location & terrain changes

4) Continue manual.

Esso

IMPERIAL OIL LIMITED

COMPTROLLER'S DEPARTMENT

P.O. Box 2356 Edmonton, Alberta

R. A. WILSON
Western Region Comptroller

C. R. PERRY
Western Region Assistant Comptroller

December 4, 1967.

Re: Project No. 483 - Arctic Pipe Line
Design and Construction
Your File: 9.666E

P/L DIVISION
FILE No. 9.666E
DEC 6 1967

	NOTE	ACT	INITIAL
KRS	✓		–
CC			
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH	✓		CVH
WJK	✓		–

DATE ANS'D 2355.

Mr. K. R. Shipley, Manager,
Transportation and Supply Dept.,
Pipe Line Division,
Imperial Oil Limited,
111 St. Clair Avenue, West,
TORONTO, Ontario.

Attention: Mr. C. V. Holmes

Dear Sir:

The schedules of expenditures relative to the Arctic Pipe Line Project are attached. As requested in your letter of November 23rd, separate schedules for each of the 1966 and 1967 years have been provided. We assume the information provided also satisfies your request that we reconcile the amounts shown on the 1967 schedule with the monthly C-220S forwarded to Don Mills. The amounts cleared to Don Mills to October 31st do not include any charges for Drilling Department or Imperial Pipe Line costs which are expected to be transferred shortly. The totals transferred from Lab Research and Engineering Research, Calgary as noted on the 1967 schedule balance to the total C-220'S cleared to date.

If we can be of further assistance, please do not hesitate to let us know.

Yours very truly,

R. A. WILSON

D Hingley /Dln

D. Hingley

D. L. Willis/ah
Section 5.1
Attach.

SCHEDULE OF EXPENDITURES RE: ARCTIC PIPE LINE PROJECT

FOR THE PERIOD JANUARY 1, 1967 TO OCTOBER 31, 1967

	Imperial Pipe Line 450-0218	PRODUCING DEPT. Drilling Dept. 450-3262	Lab. Research #3858	Eng. Research #3858	Total
Salaries, Wages & Benefits	$ 1,518.49	3,780.51	7,178.90	7,564.87	$20,042.77
Sales Tax & Import Duty				421.06	421.06
Freight	150.00	3,037.45			3,187.45
Outside Services	6,481.58	315.05	238.61	349.39	7,384.[illegible]3
Materials & Supplies	6,624.86	779.68	1,718.28	9,220.26	18,343.[illegible]8
Aircraft Rental	285.00				285.00
Travel	877.05	410.39	205.00	1,510.50	3,002.94
Company Owned Rig Clearings		2,205.00			2,205.00
Company Garage & Warehouse Overhead		265.35			265.35
Co. Owned Automotive Expense		6,938.77			6,938.77
Tech. Service Lab & Region Overhead			4,070.75	9,556.71	13,627.46
TOTAL COSTS - 1967 to Date	$15,936.98	17,732.20	13,411.54	28,622.79	75,703.51
Charged to Engineering - P/L Div. - Toronto*	(15,936.98)	(15,465.44)	(12,149.08)	(27,685.07)	(71,236.57)
Balance Uncleared	Ø	$ 2,266.76	$ 1,262.46	$ 937.72	$ 4,466.94

* IncludesP/L and Drilling Costs to be Transferred in November as follows:-

Imperial P/L 450-0218	$15,936.98
Drilling Dept. 450-3262	$15,465.44
	$31,402.42

Reconciliation

Toronto chges.	3079.01
" Rate chgs	3897.75
Wkd Compt	7123657
	78,213.33
Bkd in 1966	15,734.02
	93,947,35

Total cost including Toronto Charges for 1967 is $83,471.11

SCHEDULE OF EXPENDITURES RE: ARCTIC PIPE LINE PROJECT

FOR THE YEAR 1966

(LAB RESEARCH ONLY ACTIVITY IN 1966)

	LAB RESEARCH # 3858
Salaries Wages & Benefits	6,557.85
Dales Tax and Import Duties	78.50
Materials & Supplies	1,618.93
Outside Services	225.00
Aircraft Rental	574.00
Travel	1,227.91
Tech. Service Lab & Region Overhead	5,552.38
TOTAL COSTS - 1966	$ 15,834.57
Charged to Engineering P/L Div. - Toronto	$ 9,000.00
Balance - Absorbed	$ 6,834.57

IMPERIAL OIL LIMITED
TELETYPE MESSAGE

1

1967 NOV 30 PM 1 38

E-7 EDM NOV 30/67 10:52

K R SHIPLEY, MANAGER
T AND S DEPT - PIPE LINE DIV
ATTN C V HOLMES
TORONTO

SCHEDULES OF ARCTIC PIPE LINE PROJECT EXPENDITURES SHOULD REACH YOU TODAY 1967 SCHEDULE SHOULD BE REVISED TO READ ($15,465.44) UNDER DRILLING DEPT COLUMN SECOND LAST LINE. TOTAL CHARGED TO TORONTO SHOULD NOW READ ($71,236.57) WITH BALANCE UNCLEARED UNDER DRILLING DEPT NOW $2,266.76. LETTER TO FOLLOW

R A WILSON SEC 5.1 D HINGLEY - D L W

1967 15,465.44 71,236.57 2,266.76

10:55 GS

P/L DIVISION
FILE No. 9.666E
NOV 30 1967

	NOTE	ACT	INITIAL
KRS			
CC			
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH	✓		CVH
WJK			

DATE ANS'D

FORM 2-5859

File Nov 30/67
9.666E

D. Lew Nov 29/67

Schedule of Expenditures Re: Arctic Pipe Line Project.
For the Period January 1, 1967 to October 31, 1967.

	IMPERIAL PIPE LINE 450-0218	PRODUCING DEPT. DRILLING DEPT 450-3262	PRODUCING DEPT. LAB. RESEARCH #3858	PRODUCING DEPT. ENG. RESEARCH #3858	TOTAL
SALARIES, WAGES & BENEFITS.	151849	378051	717890	756487	
SALES TAX & IMPORT DUTY				42106	
FREIGHT	1500	303745			
OUTSIDE SERVICES	648158	31505	23861	34939	
MATERIALS & SUPPLIES	662486	77968	171828	922026	
AIRCRAFT RENTAL	28500				
TRAVEL	87705	41039	70500	151050	
COMPANY OWNED RIG CLEARINGS		220500			
COMPANY GARAGE & WAREHOUSE OVERHEAD		26535			
CO. OWNED AUTOMOTIVE EXPENSE		693877			
TECH SERVICE LAB & REGION OVERHEAD			407075	955671	
TOTAL COSTS - 1967 TO DATE	1593698	1773220	1341154	2862279	
CHARGED TO ENGINEERING - P/L DIV - TORONTO*	(1593698)	(1773220)	(1214908)	(2768507)	
BALANCE UNCLEARED.	Ø	Ø	126246	93772	

All same spacing please

*INCLUDES P/L AND DRILLING COSTS TO BE TRANSFERRED IN NOVEMBER.

Cecil - Will forward a formal
reply tomorrow.

Dan

P/2 - NOV. [illegible]/67
9.666E

Schedule of Expenditure Re: Arctic Pipe Line Project
For the year 1966 -
(LAB RESEARCH ONLY ACTIVITY IN 1966)

	LAB RESEARCH #3858
SALARIES, WAGES & BENEFITS	6557 85
SALES TAX AND IMPORT DUTIES	78 50
MATERIALS & SUPPLIES	1618 93
OUTSIDE SERVICES	225 00
AIRCRAFT RENTAL	574 00
TRAVEL	1227 91
TECH SERVICE LAB & REGION OVERHEAD	5552 38
TOTAL COSTS - 1966	15834 57
CHARGED TO ENGINEERING P/L DIV - TORONTO	9000 00
BALANCE - ABSORBED	6834 57

2-S-222/1 3/67

INTER-DEPARTMENTAL CORRESPONDENCE

FROM: D WOOD

DEPARTMENT: 5.4 DON MILLS

SEND TO: Mr. C. V. Holmes,
Room 1237
111. ST Clair

DATE: Nov 27/67

SUBJECT: SUMMARY JOB ORDER
90-450-0006

MESSAGE

Further to my speedimemo of November 22/67, attached is a copy of comptrollers Western back-up to C220's.

Please advise if this is suffient, or do you require additional information.

Thank you,
Doug Wood.

P/L DIVISION
FILE No. 9.666E
NOV 28 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		ce
OMK			
RAP			
LDA			
SMB			
CJB			
RDC			
CVH	✓		[illegible]
WJK			

DATE ANS'D 2290.

USE LOWER PORTION FOR REPLY

REPLY FROM

DATE

RE: PIPELINE RESEARCH - YOUR JOB ORDER #450-0006

C-220's.

#18995	JUNE	$ 2851 46
#58820	JULY	3412 79
#18755	AUG	4244 13
#18922	SEPT.	15464 08
#56928	OCT.	13861 69
	TOTAL	39834 15

COMPOSED OF

	LAB RESEARCH	ENGINEERING RESEARCH	
SALARIES, WAGES & BENEFITS	6380 71	7282 50	
OUTSIDE SERVICES	63 61	349 39	
MATERIALS & SUPPLIES	1429 01	8564 98	
SALES TAX & IMPORT DUTY	—	421 06	
TRAVEL	205 00	1510 46	
TOTAL DIRECT COSTS	8078 33	18128 36	
TECH. SERVICE LAB OVERHEAD	3522 77	8270 23	
REGION OVERHEAD	547 98	1286 48	
	12149 08	27685 07	39834 15

November 23, 1967

Re. Project No. 483, - Arctic Pipe Line
Design and Construction

File:9.666E

Mr. R.A. Wilson
Western Region Comptroller
Imperial Oil Limited
P.O. Box 2356
Edmonton, Alberta.

Attention Mr. D. Hingley/D.L. Willis, Sec. 5.1

Dear Sir:

We have enclosed a copy of a Schedule of Expenditures re. Arctic Pipe Line Project prepared by your department. Since these costs are being transferred to Eastern Region Comptroller's Department in Don Mills for eventual billing to Easo Research and Engineering, we are interested in obtaining the detailed costs which are not available here.

For the current year the Arctic Pipe Line Project #483 has been billed by your Department for the following amounts.

Month, 1967	Amount	
May	$ 2,851.46	
June	3,412.79	
July	4,244.13	
August	15,464.08	
September	13,861.69	
November	31,402.42	(not received at this-date)
	$71,236.57	

We would like to receive a detailed breakdown of the charges to the above project similar to the enclosed "Schedule of Expenditures" which would include Total costs to October 31, 1967 and would also give a separate total for costs incurred in 1966. If it is possible to reconcile your monthly C220s to the Eastern Region Comptroller's with the "Schedule of Expenditures" for 1967, it would be of great assistance.

We are anxious to get the above information as soon as possible so that New York may be informaed of cost to date and the budget status of Project #483.

Yours very truly,

K.R. Shipley,

By:____________________
C.V. Holmes.

CVH/EG.

Encl.

IMPERIAL OIL LIMITED

Esso

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION

E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE. EDMONTON. CANADA

November 23, 1967

Our File 37.37

Mr. K. R. Shipley, (WJK)
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

Enclosed is a print, No. F10.759-1, showing the elevations and co-ordinates of the points surveyed along the experimental pipeline near Inuvik, N.W.T., on October 27, 1967. This record of the first precise survey of the pipe itself is for your information. If you require more such prints, they are available upon request.

Also enclosed are a few slides showing the pipeline under winter conditions. Copies of some of these may add a little to the set sent to you earlier.

Yours very truly,

E. W. CHRISTIAN

John E. Lyle
J. E. Lyle

JEL/McB
Encs.

P/L DIVISION
FILE No. 9.666E
NOV 27 1967

	NOTE	ACT	INITIAL
KRS			
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OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		WJK

DATE ANS'D 22.8.5

November 23, 1967

Pumping Requirements for
Some Non-Newtonian Fluids
Report No. IPRT-9ME-67
File: 9.666E

Mr. V. C. Larson
Imperial Oil Limited
Western Region Producing Dept.
339 - 50th Avenue S. E.
Calgary, Alberta

Dear Sir:

Enclosed is a letter from Mr. L. B. Morrow dated November 21 which concurs with your recommendation that Dr. Duggins be allowed to publish portions of the subject report.

Yours very truly,

K. R. SHIPLEY

By: ____________________
C. Carlisle

CC/sr
Encl.

2-S-222/1 3/67

(INTER-DEPARTMENTAL CORRESPONDENCE)

FROM D. WOOD

DEPARTMENT 5.4 DON MILLS

SEND TO Mr. C. V. Holmes, Room 1237 111, ST CLAIR

DATE NOV 22/67

SUBJECT Reconcilation 9D-450-0006

MESSAGE

I refer to your telephone conversation of todays date. Enclosed is a copy of our reconcilation for project #483. Artic Pipeline Design + construction Problems.

If I can be of any further assistance please advise.

Thank you
Doug Wood

P/L DIVISION
FILE No. 9.666E
NOV 22 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		—
OMK			
RAP			
LDA			
DMB			
CJB			
RDC			
CVH	✓		CVH
WJK	✓		—

DATE ANS'D 2249.

DATE

USE LOWER PORTION FOR REPLY

REPLY FROM

IMPERIAL OIL LIMITED

...orrelation 90-450-0006.

...rctic Pipeline Design + Construction Problems

DEPT.
PROJECT
FILE
DATE
BY

Voucher #			DETAILS	
				0
02 -	31	35.	Prior Years balance brought forward.	
03 -	30	25		
03 -	95	02	Salary 457792.	9192.
04 -	95	02	Salary 457792.	
05 -	31	44	charged to New York	
06 -	08	62	Travelling Expenses W.S. Ki...	
06 -	31	57	Calgary expenses re Rese...	
07 -	A0	14	Course on Strain Gauges Mr. ...	9849
07 -	32	15	Calgary expenses re	
07 -	95	02	Salary 457792	
08 -	31	59	Calgary expens...	
08 -	95	02	Salary 457...	9964
09 -	31	16	Travelling Ex...	
09 -	31	36	Calgary	
09 -	31	37	charges	
10 -	31	37	ch...	
10 -	31	31	co...	Total

Novemb...

735

233 70
201 56
549 71
<4 882 72>
3 897 75
328 40
2 851 46
555 05
3 412 79
376 84
4 244 13
561 35
272 40
15 464 08
<12 330 02>
<15 736 48>
13 861 69
3 861 69

IMPERIAL OIL LIMITED

Correlation 90-450-0006.

Arctic Pipeline Design + Construction Problems.

DEPT
PROJECT
FILE
DATE
BY

Voucher #	DETAILS	3107	8601 T&S	8900	9192.	9899. T&S	9964	Total
02 - 31 35	Prior Years balance brought forward.			3 897 75				3 897 75
03 - 30 25						549 71		549 71
03 - 95 02	Salary 457792.					201 56		201 56
04 - 95 02	Salary 457792.					233 70		233 70
05 - 31 44	charged to New York						<4 882 72>	<4 882 72>
06 - 08 62	Travelling Expenses W.J. Keys.		328 40					328 40
06 - 31 57	Calgary expenses re Research costs.				2 851 46.			2 851 46
07 - A0 14	Course on Strain Gauges Mr C. Duncan	555 05						555 05.
07 - 32 15	Calgary expenses re Research costs.				3 412 79.			3 412 79
07 - 95 02	Salary 457792					376 84		376 84
08 - 31 59	Calgary expenses re Research costs.				4 244 13			4 244 13
08 - 95 02	Salary 457792					561 35		561 35
09 - 31 16	Travelling Expenses W.J. Keys		272 40					272 40
09 - 31 36	Calgary expenses re Research costs				15 464 08			15 464 08
09 - 31 37	charged to New York						<12 330 02>	<12 330 02>
10 - 31 37	charged to New York.						<15 736 48>	<15 736 48>
10 - 31 31	Calgary expenses re Research costs				13 861 69			13 861 69
		555 05	600 80	3 897 75	39 834 15	1 923 16	<32 949 22>	13 861 69
						582 23		
	Billed to New York in November $ 13 861 69					2 505 39	<13 861 69>	
							46 810 91	
November	Calg expenses re Research costs				31 402 42 –		31 402 42	
							78 213 33	
					2 557 31	1966 →	15 734 02	
							93 947 35	
					2 105 64			
					75 899 52			

Billed to New York	78 213 33
December Billing (West)	2 557 31
December " (West)	2 105 64
Grants	504 83
Total charges 1967	$83 471 11

...ation 90-A50 · 000...

Artic Pipeline Design + Construction Problems

FILE
DATE
BY

Voucher #	DETAILS	31
02 - 31 35	Prior Years balance brought forward.	
03 - 30 25		
03 - 95 02	Salary 457792.	
04 - 95 02	Salary 457792.	
05 - 31 44	charged to New York	
06 - 08 62	Travelling Expenses W.S. Kegs.	
06 - 31 57	Calgary expenses re Research costs.	
07 - AO 14	Course on Strain Gauges Mr. C. Duncan.	
07 - 32 15	Calgary expenses re Research costs.	
07 - 95 02	Salary 457792.	
08 - 31 59	Calgary expenses re Research costs.	
08 - 95 02	Salary 457792.	
09 - 31 16	Travelling Expenses. W.S. Kegs.	
09 - 31 36	Calgary expenses re Research costs	
09 - 31 37	charged to New York.	
10 - 31 37	charged to New York.	
10 - 31 31	Calgary expenses re Research costs	

Billed to New York in November $ 13 861 69

November Calgary expenses re Research costs

Billed to New York	7821333
December Billing (West)	255731
December " (West)	210564
Toronto	59483
Total charges 1967	$83471 11

DEPT. ____________
PROJECT ____________
FILE ____________
DATE ____________
BY ____________

	3107.	8601 T&S	8900	9192.	9899. T&S
...rward.			3 897 75		
					549 71
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...s.				2 851 46.	
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...ts				13 861 69	
	555 05	600 80	3 897 75	39 834 15	1923 16
					582 23
$ 13 861 69					2505 39
				31,402 42 –	
				2557 31	1966 →
				2105 64	
				75899 52	

Standard Oil Company

INCORPORATED IN New Jersey

30 ROCKEFELLER PLAZA, NEW YORK, N. Y. 10020

Transportation Coordination Department

L. B. MORROW
Manager, Pipe Line Research

November 21, 1967

Imperial Oil Limited
Pipe Line Division
111 St. Clair Avenue, West
Toronto, Ontario, Canada

Attention: Mr. C. Carlisle

Pumping Requirements for
Some Non-Newtonian Fluids
Report No. 1PRT-9ME-67

Dear Sir:

My apology for the delay in answering your letter of October 23, recommending that Dr. Duggins be allowed to publish portions of the subject report. I agree with your conclusions that most of the information covered is basic and does not apply to any one pipeline system.

Even though it is usually not desirable to publicize the research work prior to completion, I see no real objection in this instance and therefore concur with your recommendation.

Your s very truly,

L. B. Morrow

L. B. Morrow

LBM:ms

P/L DIVISION
FILE No. 9.666E
NOV 23 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		cc
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK			

DATE ANS'D 22/61

November 14, 1967

<u>Re: Arctic Test Piepline - Project #483</u>

File: 9.666E

Mr. V.C. Larson'
Imperial Oil Limited
Production Research & Tech. Serv. Lab.
339 50th Avenue S.E.
Calgary, Alberta.

<u>Attention Mr. R.A. Hemstock</u>

Dear Sir:

We regret the delay in replying to your letter of October 17, 1967 on the above topic. Your attached report is very good and covers the test installation program very well.

From a recent telephone conversation with Mr. J.E. Lyle it was understood that the plans to "kick-off" the readings for stress analysis and to make an in place survey have already been put into action.

Your proposed plan for future project activity looks very good. We hope to review this in more detail later on when there is an opportunity, however, you should proceed with the programme as planned.

We are presently trying to get an up-to-date figure on the 1967 budget expenditures as of the middle of November. This was discussed with Mr. A. Hemstock about a week ago and we will advise as soon as the information is made available from Comptroller's.

Yours very truly,

K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.
cc. Mr. J.E. Lyle, Imperial Pipe.

Esso

P/L DIVISION
FILE No. 9.666E
NOV 10 1967

	NOTE	ACT	INITIAL
KRS	✓		
CC	✓		CC
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH	✓		CVH
WJK	✓		WJK
DATE ANS'D	21/57		

IMPERIAL OIL LIMITED

G. R. McLELLAN
Comptroller

W. K. TANNER
Assistant Comptroller

111 St. Clair Avenue West, Toronto, Canada

November 10, 1967.

N.W.T. PIPELINE PROJECT

File: 250.2
Code: P

Mr. R.A. Wilson,
Western Region Comptroller's,
Edmonton, Alberta. Attn: Mr. D. Hingley, Dept. 5.1/DLW

Mr. D.D. Lougheed,
Western Producing Dept.,
Calgary, Alberta. Attn: Mr. J.J. Pitzel.

Dear Sir:

We have received copies of recent correspondence re the above project. We would like to advise that this project is in no way connected with our Producing Research Agreement. Therefore, the proper procedure is being followed in not reporting expenditures to Esso Production Research Company.

Producing Western and Imperial Pipe have been working on a contract basis for our Pipeline Division in carrying out this work. Here again the correct procedure has been followed in transferring associated charges to Pipeline Division, Toronto. The project has been assigned to us under terms of the Pipeline Research Agreement and therefore, Esso Research and Engineering Company is ultimately charged with expenditures incurred.

We trust the above explanation will serve to clarify this matter.

Yours very truly,
W.K. TANNER

J.P. Byers : JM Per: JPB

c.c. Mr. L.H. Allin, Room 710, Building.
Mr. C.V. Holmes, Room 1237, Building.
Mr. S.F. Weller, Room 744, Building.

NOTE TO MESSRS. ALLIN/HOLMES/WELLER - It appears that our 1967 budget for this project will be over run, although there was a large under run in 1966. Suggest that your Department should follow directly with Pipeline Division if you wish to recover the $6,800 absorbed by Producing West in 1966.

NOV 2 1967

October 23, 1967.

Re: Pipeline Research Project - N.W.T.

AHC

[illegible] he aware, expenditures in the order of $30,000 [illegible] have been incurred by the Calgary Lab, Drilling [illegible] Pipe Line on the above project, which we understand commenced at the request of [illegible]. Although these costs have been incurred in the West, they are transferred monthly to Toronto since the project is administered by Transportation and Supply Department head office, (Dave Holmes) and/or the Pipeline Division of the Engineering Department (John Payne).

As a result, these costs are not reported in our Statement of Expenditures on Mutualized Research forwarded to E. R. E. Company, although we understand they do come under the mutualized category. Would you confirm that (1) the costs, as summarized on schedule "A" attached are in fact, applicable as "mutualized" expenditures (in whole or in part) and (2) if so, are these expenditures being reported by Toronto or should they be included in our submission to E.R.E. Company.

It is interesting to note that, although all applicable 1967 Lab costs have been transferred to Toronto, the lab absorbed $6,834.57 in 1966, costs relative to this project. It would appear that budget matters influenced this decision. The absorbed amount was not reported as a mutualized expenditure.

Yours very truly,

H. A. WILSON

H. A. W.

D. Pingley

B. L. Willis/ew
Section 5.1

cc: Mr. J. W. Campbell, Calgary Lab
Mr. J. E. Burns, Calgary Producing
Mr. E. H. Allin - Toronto - Comptroller's Department

October [illegible], 1967.

Re: Pipeline Research Project - N.W.T.

Mr. [illegible],
Budget Co-ordinator,
[illegible] Department,
Calgary, Alberta.

Dear Sir:

As you may be aware, expenditures in the order of $59,000 to August 3rd, 1967, have been incurred by the Calgary Lab, Drilling Department, and Imperial Pipe Line on the above project, which we understand commenced at the request of S.O.N.J. Although these costs have been incurred in the west, they are transferred monthly to Toronto since the project is administered by Transportation and Supply Department head office, ([illegible] Holmes) and/or the Pipeline Division of the Engineering Department (John Keyes).

As a result, these costs are not reported in our Statement of Expenditures on mutualized research forwarded to E. P. R. Company, although we understand they do come under the mutualized category. Would you confirm that(1) the costs, as summarized on schedule "1" attached are in fact, applicable as "mutualized" expenditures (in whole or in part) and (2) if so, are these expenditures being reported by Toronto or should they be included in our submission to E.P.R. Company.

It is interesting to note that, although all applicable 1967 lab costs have been transferred to Toronto, the lab absorbed $6,834.57 in 1966 costs relative to this project. It would appear that budget matters influenced this decision. The absorbed amount was not reported as a mutualized expenditure.

Yours very truly,

R. A. WILSON

D. Hingley

D. L. Willis/ew
Section 3.1

cc: Mr. J. W. Campbell, Calgary Lab
Mr. J. E. Burns, Calgary Producing
Mr. L. R. Allin - Toronto - Comptroller's Department

SCHEDULE OF EXPENDITURES RE ARCTIC PIPE LINE PROJECT - TO AUGUST 31, 1967

	Imperial Pipe Line 430-0218	PRODUCING DEPARTMENT Drilling Dept. 430-3262	Lab Research #3838	Eng. Research #3839	Total
Salaries, Wages & Benefits	1,336.28	2,469.42	11,373.24	5,720.43	20,899.37
Sales Tax and Import Duty			78.50	421.06	499.56
Freight		492.20	13.00	8.25	513.45
Outside Services	1,172.85	125.05	238.61	349.39	1,885.90
Materials & Supplies	1,520.19	80.00	2,068.17	3,949.41	7,617.77
Travel	521.65	157.77	1,432.91	1,032.87	3,145.20
Aircraft			574.00		574.00
Rig Clearings		2,205.00			2,205.00
Garage & Warehouse Charges		255.36			255.36
Automotive Expense		6,938.77			6,938.77
Tech. Service Lab Overhead			8,467.36	5,970.33	14,437.69
TOTAL "COSTS TO AUGUST 31, 1967	$ 4,550.97	12,723.57	24,245.79	17,451.74	58,972.07
CHARGED TO ENGINEERING - P/L DIVISION - TORONTO	(4,550.97)	(12,723.57)	(17,520.72)	(17,451.74)	(52,247.00)
BALANCE - ABSORBED BY PROD. WESTERN	-	-	$6,725.07	-	$6,725.07

October 23, 1967

File: 9.666E

Mr. L. B. Morrow
Transportation Coordination Dept.
Standard Oil Company
30 Rockefeller Plaza
New York, N. Y. 10020

Dear Sir:

Enclosed is a letter dated October 18 from Mr. V. C. Larson covering Report No. IPRT-9ME-67, Pumping Requirements for Some Non-Newtonian Fluids.

We concur with Mr. Larson's recommendation that Dr. Duggins be given permission to have portions of the report published since the information it contains is basic and would require refinement to be applicable to any particular pipe line system.

As this work was conducted under PLR Project #483, would you please advise if you concur with our recommendation.

Yours very truly,

K. R. SHIPLEY

By: ________________
C. Carlisle

CC/sr
Attach.

cc: Mr. V. C. Larson

IMPERIAL OIL LIMITED

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION

E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE, EDMONTON, CANADA

October 18, 1967

Our File 37.37

Mr. K. R. Shipley (WJK),
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

As requested in our recent telephone conversation, enclosed are three prints of slides borrowed from Mr. Gerry Rempel, I.O.E., showing the effect on permafrost of winter roads in the Canadian Arctic.

Yours very truly,

E. W. CHRISTIAN

John E. Lyle
J. E. Lyle

JEL/McB
Encs.

Pictures held here. wjk

P/L DIVISION
FILE No. 9.666E
OCT 20 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		ec
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		OC JK

DATE ANS'D 20/30.

IMPERIAL OIL LIMITED

339 - 50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

PRODUCTION RESEARCH AND TECHNICAL SERVICE LABORATORY

WESTERN REGION PRODUCING DEPARTMENT

V. C. LARSON
MANAGER

P/L DIVISION
FILE No. 9-666E
OCT 31 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		CC
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		WJK

DATE ANS'D 20-12

October 17, 1967

Mr. K. R. Shipley
Manager
Transportation & Supply Dept.
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

Re: Arctic Test Pipeline - Project No. 483
Stress Analysis

Attached are four copies of Laboratory Report No.L-63767 discussing the recent installation and instrumentation of the test pipeline.

Final installation was almost totally as planned and results are anticipated to be good.

Comments are included regarding construction and the general pipeline right-of-way.

Final arrangements are now being made with J. E. Lyle to obtain a precise survey of the line and to commence the data collection.

Recommendations for further detail on corrosion problems are proposed for consideration.

Please advise if this meets with your approval.

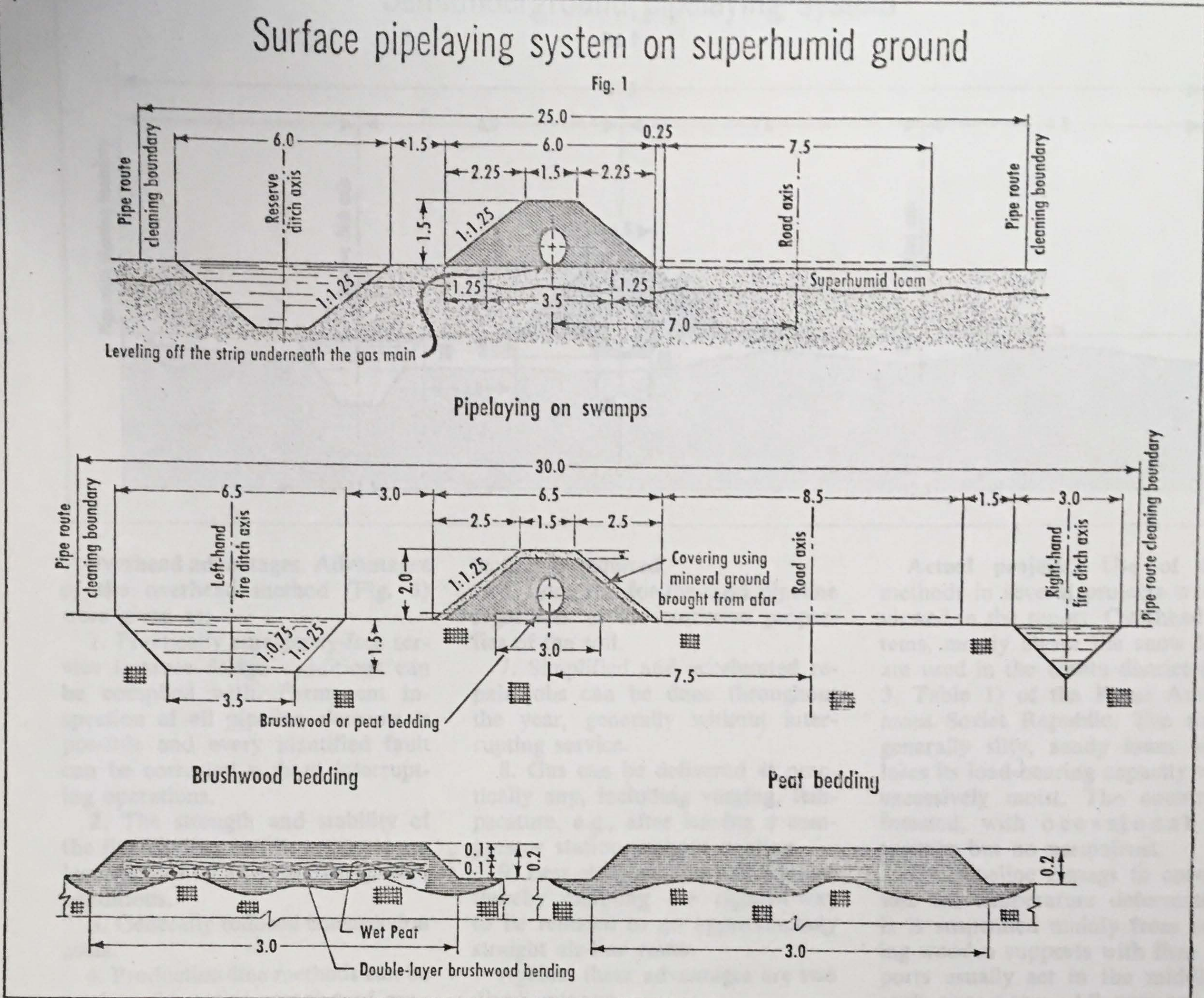
Yours very truly

VCLarson

V. C. Larson

CD/mt
attach.

cc: J. E. Lyle
R. A. Hemstock
file 662
l.r.
day



Soviets use unorthodox methods to lay pipelines in far north

Overhead, surface, and semiunderground methods are used to meet varying conditions in northern territories where intense cold, snow, swamps, and permafrost limit use of conventional pipelaying methods.

SEMIÚNDERGROUND, surface, and overhead methods of laying pipelines are being used to meet the rigorous climate and terrain conditions that exist in the northern territories of the U.S.S.R.

How these methods are employed, their advantages and their disadvantages, were described in a report made to the International Gas Congress in Hamburg. Authors were S. V. Konopasevich, P. P. Leiman, and M. O. Pereltsvaig.

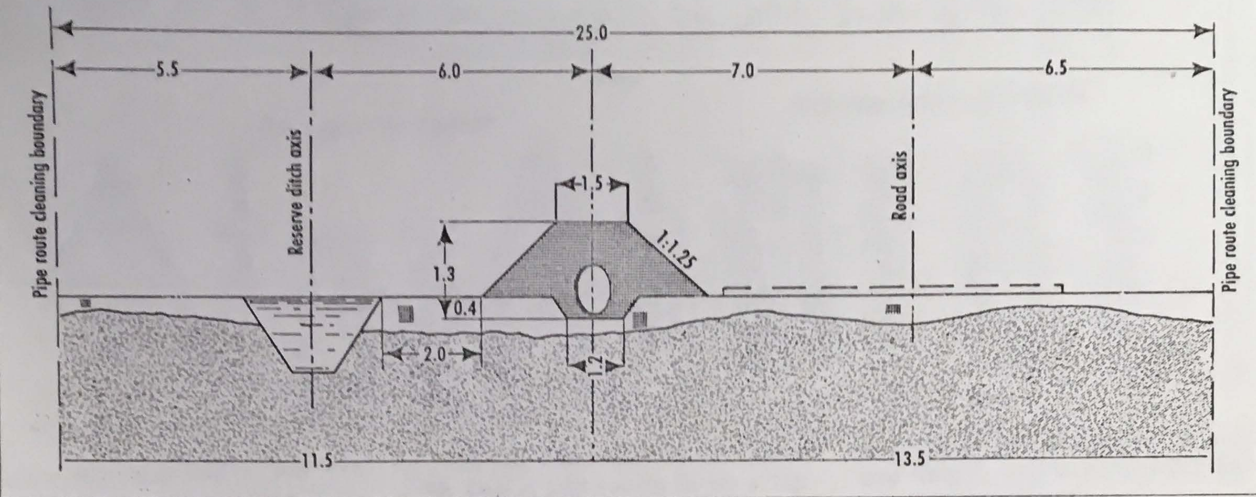
Surface (Fig. 1) and semiunderground (Fig. 2) pipelaying methods were considered together. These advantages were reported:

1. Pipelaying costs are reduced by nearly 20% and the earthwork volume by 50 to 60%.
2. The pipeline does not have to be anchored with heavy weights.
3. Earthwork can be done in a single cycle, thereby preventing freezing of the spoil when earthwork is done in winter.

The one disadvantage is the need for maintaining a ground ridge over the pipeline. The ridge interferes with the flow of surface water and driving across the route.

Semiunderground pipelaying system

Fig. 2



Overhead advantages. Advantages of the overhead method (Fig. 3) were given as:

1. Practically emergency-free service because design conditions can be complied with. Permanent inspection of all pipeline elements is possible and every identified fault can be corrected without interrupting operations.

2. The strength and stability of the flexible line and its supports are less affected by adverse frost-ground conditions.

3. Generally reduced construction costs.

4. Production-line methods can be used in the entire complex of construction-erection work throughout most of the year. Work on swamps and rivers is even easier in winter than in summer.

5. Neither complicated anticorrosive insulation nor cathodic protection is required.

6. Long life for the steel pipeline regardless of the corrosive properties of the soil.

7. Simplified and accelerated repair jobs can be done throughout the year, generally without interrupting service.

8. Gas can be delivered at practically any, including varying, temperature, e.g., after leaving a compressor station without cooling.

9. Less-stringent route conditions thereby enabling the right-of-way to be reduced to an approximately straight air-line route.

Against these advantages are two disadvantages:

1. Limitation of free travel across the route except for special crossings.

2. Great vulnerability to external effects, including those caused by malicious intent.

Actual projects. Use of these methods in several projects was reviewed in the report. Overhead systems, mostly above the snow level, are used in the Ukhta district (Col. 3, Table 1) of the Komi Autonomous Soviet Republic. The soil is generally silty, sandy loam which loses its load-bearing capacity when excessively moist. The country is forested, with occasional peat swamps but no permafrost.

The pipeline zigzags to compensate for temperature deformations. It is suspended mainly from swaying wooden supports with firm supports usually set in the middle of each zigzag arm. All supports rest on pads except those in swamps which are set on piles. More than 300 km of 200 to 400-mm pipelines have been set in this manner in the last 20 years.

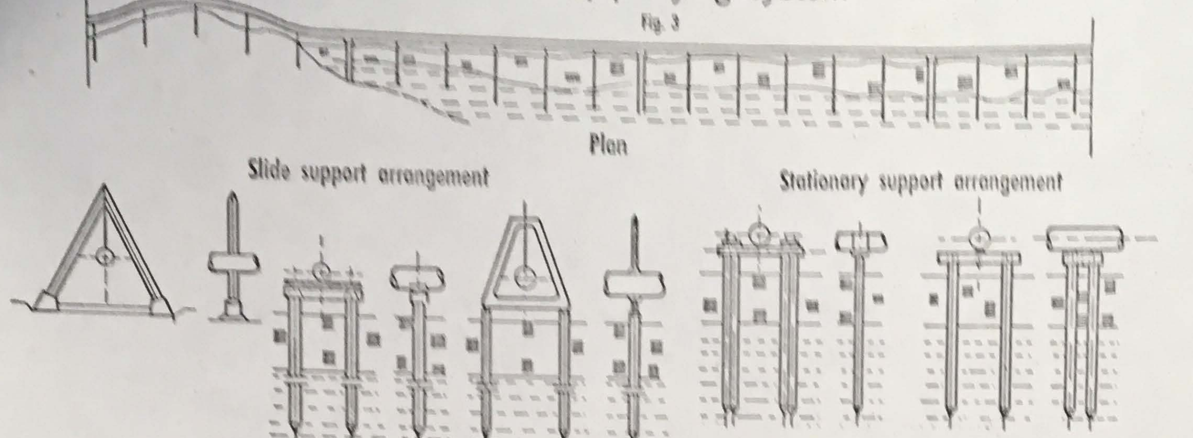
More recently, some 100 km of

Basic climate features—Table 1

Observation points / Meteorological features	Leningrad lat. N. 59° 56′ long. E. 30° 16′	Moscow lat. N. 55° 46′ long. E. 37° 37′	Ukhta lat. N. 63° 33′ long E. 53° 50′	Vorkuta lat. N. 67° 36′ long. E. 64° 0′	Novi Port lat. N. 67° 42′ long. E. 72° 57′	Iakutsk lat. N. 62° 01′ long. E. 129° 45′	Bodaibo lat. N. 57-50′ long. E. 114° 12′	Punga lat. N. 62° 46′ long. E. 64° 22′	Tarko-Sale lat. N. 64° 55′ long. E. 77° 49′
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Average air temperature, °C.	4,2	3,6	− 0,2	− 6,3	− 9,1	−10,2	− 5,8	− 4,0	− 6,0
January average	− 7,2	−10,3	−16,4	−20,2	−26,0	−41,6	−31,4	−22,4	−24,0
July average	17,7	17,8	19,2	15,6	12,1	23,1	23,1	15,9	15,3
Absolute minimum	−36°	−42°	−52°	−54°	−57°	−64°	−60°	−52°	−52°
Absolute maximum	32°	35°	33°	31°	27°	38°	37°	32°	33°
Days in year with snow cover	132	146	202	232	247	206	194	200	229
Average of maximum decade heights of snow cover in winter, cm	32	52	76	48	83	30	51	64	..
Days in a year with snowstorms (wind velocity 15 m/sec)	25	25	30	80	90	7	10	30	57
Maximum wind velocity m/sec (5% repetition)	27	..	27	34	36	22	22	28	35
Severity of weather according to Bodman	1,8	2,0	2,8	3,9	4,0	2,95	2,94	3,0	3,6

Overhead pipelaying system

Fig. 3



400-mm pipe was laid on low supports below the snow surface. Temperature deformations were compensated for by using bent trapezoid-shaped expansion pieces above the surface of the snow. About 800 km of 100-150-mm-diameter field lines was also laid by this method.

Igrim-Serov line. Swamps and water-logged areas on the Igrim-Serov gas pipeline (Col. 8, Table 1) were crossed using the surface and semiunderground methods. The rest of this line was laid in conventional form.

Ditches were dug on both sides of and close to the pipeline in areas where the surface and semiunderground methods were used. Earth from the ditches is used to make a ridge over the pipeline. Special measures are taken to protect the ridge including drainage and slope reinforcement. The latter includes using mineral ground, planting grass, and sodding.

In swamps with low load-bearing capacity, below 0.1 kgf/cm³, the top layer of peat is reinforced with brushwood bedding.

Permafrost work. The first pipeline to be laid in the permafrost region is the Taas-Tumus-Iakutsk-Pokrovsk line (Col. 6, Table 1). The permafrost layer is about 200 m thick with a seasonal thaw depth of from 0.5 to 3.5 m depending on water content, vegetation cover, etc. Ice of varying thickness has been encountered at shallow depths. In some instances boreholes up to 7 to 8 m in depth have failed to pierce the ice.

On the first third of the route, this line is laid overhead on a zigzag contour. It is suspended on swaying supports except in waterbogged areas where sliding supports are used. In sections subject to high floods, the pipe is carried on pile supports with attachments to prevent it from floating in high water.

Conditions are more favorable on the remaining two-thirds of the route and the pipe is laid by conventional methods. Cover is from 0.7 to 0.8 m.

Right-of-way surveying is extremely difficult in summer because of the lack of roads, swamps, and an abundance of pests such as gnats and midge. In winter it is more difficult because of the short days, severe cold and strong wind, and deeply frozen ground which make boreholes almost impossible.

In permafrost areas consideration must be given to local frost-ground conditions such as depth, size and thickness of underground ice, possible swelling, ground solifluction, frost cracking, etc. These must be considered also in the light of seasonal changes.

Overhead problems. Particular problems in surveying routes where the overhead method of pipelaying is to be used are leveling at every point where a support is to be set. In surface and semiunderground laying, special consideration must be given to water runoff.

In semiunderground laying, the pipe is buried to 0.4 or 0.5 of pipe diameter. This method and surface laying can be used effectively in swamps, in areas of superhumid ground (within 1.5 tons/m³ in volume weight), and in permafrost that is low in ice content.

Surface and semiunderground methods are adaptable if the right-of-way does not adjoin periodically flooded river plains, if the longitudinal or lateral slope does not exceed 0.01-0.02, if farm areas are avoided, and if the line is laid either straight or within a natural bending radius.

Overhead pipelaying is effective in swamps of low load-bearing capacity and great depth and in permafrost where a gas-heated line would cause settling or other movement.

Recommendations. Because of the multitude of difficulties in laying pipelines in the northern territories, the authors make these recommendations:

1. Installation of dual main lines in sections.
2. Improved welding and stringent inspection.
3. Maximum automation and telemetry to reduce high-cost maintenance staffs.
4. Maintenance service with reliable vehicles to meet swamp and snow conditions.
5. Construction of primitive structures along the right-of-way to be used both during construction and later.
6. Concentration of maintenance personnel at compressor stations.
7. Setting up "winter camps" at 10-15-km intervals for shelter in bad weather or in case of transport breakdowns.

IMPERIAL OIL LIMITED

October 17, 1967

Mr. K. R. Shipley
Manager
Transportation & Supply Dept.
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

Re: Arctic Test Pipeline - Project No. 483
Stress Analysis

Attached are four copies of Laboratory Report No.L-63767 discussing the recent installation and instrumentation of the test pipeline.

Final installation was almost totally as planned and results are anticipated to be good.

Comments are included regarding construction and the general pipeline right-of-way.

Final arrangements are now being made with J. E. Lyle to obtain a precise survey of the line and to commence the data collection.

Recommendations for further detail on corrosion problems are proposed for consideration.

Please advise if this meets with your approval.

Yours very truly

COPY (Original Signed) V. C. Larson

V. C. Larson

CD/mt
attach.

cc: J. E. Lyle
R. A. Hemstock
file 662
l.r.
day

COPY

IMPERIAL OIL LIMITED

October 17, 1967

Mr. K. R. Shipley
Manager
Transportation & Supply Dept.
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Ontario

<u>Attention: Mr. W. J. Kaye</u>

Dear Sir:

<u>Re: Arctic Test Pipeline - Project No. 6[illegible]
Stress Analysis</u>

Attached are four copies of Laboratory Report No. L-63767 discussing the recent installation and instrumentation of the test pipeline.

Final installation was almost totally as planned and results are anticipated to be good.

Comments are included regarding construction and the general pipeline right-of-way.

Final arrangements are now being made with J. E. Lyle to obtain a precise survey of the line and to commence the data collection.

Recommendations for further detail on corrosion problems are proposed for consideration.

Please advise if this meets with your approval.

Yours very truly

COPY (Original signed) V. C. Larson

V. C. Larson

CP/mt
attach.

cc: J. E. Lyle
R. A. Hemstock
file 632
I.S.
day

COPY

LABORATORY REPORT NO. L-63767

ARCTIC PIPELINE PROJECT INSTALLATION INUVIK, N.W.T.

Reference: Laboratory Report No. L-36967.

Conclusions

1. The special equipment purchased for this project gave good sound service and results are anticipated to be as designed.

2. Strain gauge installation during all types of weather can be accomplished quickly and efficiently using the welded Microdot gauges and Unitek spot welder.

3. Of the 104 gauges installed, only 3 were later found to have been made inoperable as a result of backfilling.

4. Moisture-proofing of the thermistors was not as successful as was originally anticipated.

5. Pipeline operations were hampered by the unusual methods employed in this operation but the end result was almost completely as planned.

6. The pipeline right-of-way was badly upset in sloped areas where "ditching" was attempted. This led to extensive mud and water flows, particularly down the ditch, which produced considerable erosion.

7. The line section (approximately 100 feet) covered by wood chips resulted in the best looking section with regard to upset terrain. The problem in employing this technique extensively in this area would be the meager timber supply available.

8. Personnel at the Dominion Government Research Centre in Inuvik indicated that lakes normally freeze to a depth of 4 feet in this area thus the entire line section through Gaynor's Lake will be frozen in.

9. On first estimation, the most direct means of pipeline installation in these regions would be surface installation of bare line. If, however, oil viscosity conditions require the use of heated line, then an insulated surface line would seem attractive.

10. Pipe damage would not be considered to be excessive under normal conditions. However, as a result of the several points of loading and unloading, a significant number of joints were found to have been marked. In any future large project this factor would require extreme precautions, particularly since adequate handling facilities are not presently available at the Inuvik dock.

../2

11. The permafrost level was not apparently affected by road construction. The road was built simply by packing gravel on top of the normal surface. The original gravel-surface interface was observed to be still in permafrost but the frost level had not risen up into the gravel pack.

12. Bacteria of three general types, i.e. aerobe, anaerobe, and sulfate-reducing were all found in significant numbers in the lake water. All but sulfate reducers were also found in a ground water sample.

Observations

I. Construction

(a) Handling and Transport Facilities

Existing handling facilities at Inuvik are limited. The barges are certainly capable of servicing any size of pipe under consideration but loading and unloading would not be satisfactory with current equipment.

The general route south could be serviced from the Mackenzie at any number of points but riverside docking facilities would be required.

A line routed from Whitehorse down to Skagway could be easily serviced by the existing rail route thus construction on this leg could be year-round.

Winter supply routes are apparently no longer used due to the high cost. Careful planning could utilize the less costly river route.

(b) Test Line Pre-Assembly

The pipe was found stored in a lot which allowed prefabing of all of the fittings before moving to the right-of-way.

This allowed the welder to gain a good head start and take advantage of good weather conditions.

The pipe was taken by truck to the roadside near the right-of-way and piled to allow the welder to operate from two fixed locations. The pipe was double-jointed at this point. The line was then dragged down toward the lake with the double joints attached as the line was moved forward.

(c) "Cat" Clearing Operations

In order to assess the clearing operation, a test strip of ground was cleared to permafrost and the "Cat" ripped a test ditch. This was accomplished after the Cat had made 4 passes over the ditched portion with the ripper.

The end result was a suitable ditch for test purposes but demonstrated the difficulty of physically breaking the permafrost.

It also became apparent that melting and mud would also be a problem since mud was immediately evident after moss removal. The cleared section was 6 inches deep in mud after 2 days and was a clear indication of what was to happen on the right-of-way.

Cat operation on the cleared right-of-way reduced the area to a quagmire. At every turn, the machine was tearing the moss out under the tracks and crushing the cover into a mud pulp.

The moss tended to roll up on the cat blade like a carpet when clearing was being done. This caused the later backfilling and covering operation some difficulty since the moss could ot be disentangled. The end result was an effective loss of approximately 2/3 of the original covering capability.

The line was located to one side of the cleared right-of-way. The cover was piled immediately beside the line leaving the widest portion of the cleared path open for vehicle travel.

The Cat was required to move the instrument crew equipment as well as servicing the pipeline crew. As a result, the right-of-way was damaged more than would normally be expected due to the extra traffic it received.

These observations were generally true for the entire route of the line with the exception of the surface pipe and the 100-foot section where cover was fabricated of wood chips.

(d) Test Line Assembly

The 6-Inch Section:

The 6-inch section was welded near the highway and dragged to the lakeshore. A cable was then connected to the flanged end of the line and run across the corner of the lake. The Cat then pulled the line across the lake and up the right-of-way on the north shore.

The instrumentation was then installed on the south shore. The line was pulled farther north in order to expose the instrumenta-

tion location on the north end. Gauges and thermistors were installed on the north end and the line was then dragged south to its final position with the strain gauges and thermistors under water at both shores. The remaining gauges were then installed.

The line was held up by timbers in order to prevent the strain gauges and thermistors from being torn off the bottom of the pipe while it was being moved back and forth and also to allow an estimation of stress induced in laying the pipe.

The floating section was sunk by pumping 15 bbl of diesel fuel into the line. The lake entry on the south end was quite abrupt, thus the line was completely under water. At the north shore, however, the lake shore was very shallow for a considerable distance along the line thus the line was partly awash at this point.

Gaynor's Lake Crossing

As a result of the shallow bottom along the line, the entire line is expected to be frozen-in during the winter. The normal ice depth is in the order of 4 feet in this area according to observations of the Government Research personnel.

The lake itself is also interesting in that the surface permafrost was unaffected to within about 1 foot of the water where id dropped off almost vertically. The lake bottom at the shore was silt and frost could not be found beneath the water. A depth of about 3 feet of silt was observed by probing within 2 feet of the shoreline.

Water samples were taken from the lake (at a depth of 1 foot) and from a small pool of ground water created by melting frost. Bacteria counts on these samples were as follows:

	Lake Water	Ground Water
Aerobes	10^4	$>10^6$
Anaerobes	10^5	$>10^6$
Sulfate Reducers	10^2(10^4 slime)	nil (10^6 slime)

Presence of the sulfate-reducing bacteria indicate the possibility of bacteria corrosion taking place.

This will be checked using two short pipe samples exposed in the lake.

The 16-Inch Section

The 600-foot section of 16-inch line required a ditch deeper than the front end ripper could make in one pass. The section was

cleared and began to melt. This resulted in the correct ditch depth.

Once uncovered, the permafrost melted back as much as 4 to 6 inches each day. Temperatures varied a great deal but the above rate would be typical of 70°F weather.

Melting was held in check during August 7 to 14 by cooler weather. If the temperature had remained high, operation would have been made very difficult by mud flows and deep holes.

The Road Crossing and 10-Inch Line

The road crossing required extensive ditching on each side to place the pipe beneath the road drainage ditches. This was particularly true of the southern side where a cut of 4 - 5 feet was required. This ditch was made using jackhammers, picks, and shovels The local labor was used for this job.

The hand-digging continued from the road and through the 100-foot section of wood chip cover.

It was interesting to note that a 6½-ft deep ditch was required through the road and no permafrost was encountered. The frost level was at about 7½ feet down from the road crown. There was some depression of the frost below this level at the roadside ditches. The permafrost thus appeared to follow the same elevation under the road as there was on either side. There was no visible elevation of the frost level under the road.

The creek crossing posed a problem as a result of three factors:

1. the creek bed was deep and narrow and heavily cluttered with old deadfall which had been overgrown. No means were available to clear this material;

2. as a result of the steep pitch the Cat could not effectively operate in the confined space; and

3. no proper pipe-bending apparatus was available.

As a result, the crossing was cleared as much as was possible and partially ditched on either side. The pipe was bent using both the Cat and the Nodwell but in bending, the line kinked.

The pipeline anchors were built from 13-inch casing set 8 feet in a hole augered by a Nodwell-mounted rathole digger. The north end anchor was et at grade but the south end anchor was set about 1½ feet above grade. A section of the final 200 feet of line was thus above grade at the anchor and over the creekbed.

(e) Backfilling

Backfilling was all done with the Cat. As mentioned previously, the moss had rolled and balled up to such an extent that there was insufficient backfill available to re-cover the entire right-of-way and only the requisite pipe covering was accomplished.

Government Research personnel indicated that the open areas would probably have grass growing naturally within 2 years but a supply of seed was made available and with their cooperation this was to be spread over the more heavily damaged areas.

The wood-chip cover section was accomplished as planned but this required the collection of all of the fallen trees along the entire line route. The operation of the chipper was very interesting with regard to the ease with which trees of all sizes were reduced in a matter of seconds. The chips were collected on drop sheets to limit material loss.

Line markers were installed at intervals along the entire route to mark line movement and to assess collapse or compaction of the line cover.

II. Instrumentation

(a) General Remarks

The spot welding apparatus and soldering irons were supplied by power from a small A.C. welding machine. As a result of the weight of this unit and the cable reels required, the entire equipment load was carried on a small stone boat which the Cat could pull along the pipeline from station to station.

This arrangement allowed the equipment to be accesssible and facilitated keeping everything under cover during the inclement weather and out of the mud.

The stone boat was located at each station in such a way that operations could be carried out 50 feet in either direction along the line.

Actual installation of thermistors and strain gauges consisted of the following steps:

1. marking the station pole location;

2. marking the gauge locations;

3. location of the condulets used to make the strain gauge lead conductor wire connection. These were held in place by electrician's tape then banded to the pipe with metal strapping;

4. pipe surface preparation and welding of gauges and thermistors;

5. measured lengths of conductor were run off the roller-mounted reel, were cut and banded to the pipeline; and

6. while the conductor connections were being made to the strain gauge and thermistor leads, the main station terminal box was being assembled.

The terminal boxes were mounted on 2-inch pipe by brackets welded to the pipes and bolted to the boxes. The boxes were oriented in such a way as to allow water to drain off exposed surfaces and the lids all faced away from prevailing winds.

Equipment listed in Lab. Report No. L-36967 was altered slightly as shown in the attached installed-equipment list.

Pre-assembly of the condulet junction boxes, panel boards, thermistors etc. resulted in a significant time-saving on installation.

(b) Gauge Installation

Actual installation went smoothly when experience was gained in locating and assembling the first few strain gauges. The gauge leads are hermetically sealed within a stainless steel tube and the tube is welded to the gauge flange. This point of contact proved to be very fragile and could not stand any force being exerted on it. Several gauges were found to be inoperable as a result of bending and had to be replaced.

The stainless steel tube had to be bent to allow the gauge to sit flat in position while allowing the tube to run freely through the conax seal into the junction box. Upon checking the first installations, the gauge reading was found to fluctuate if the tube was touched. The metal pieces brought to Inuvik as protection for the gauges did not prove adequate so 3-inch pipe was cut into 8-inch lengths and then cut again longitudinally to provide shells which covered the gauges, thermistors, and leads. These shells were strapped or tack-welded directly to the line and provided good gauge protection.

(c) Moisture-Proofing

The thermistor epoxy moisture seal, both on the stainless steel shim stock and at the lead to conduit connection, was not entirely adequate. The epoxy was covered with RTV (rubber cement) and electrical tape, followed by an epoxy-coal tar moisture proofing, polyken tape, and a final epoxy-coal tar application but the final survey showed significant leakage at several points.

Moisture-proofing the strain gauge to conduit connection in the bottom junction box proved to be most troublesome. The final method used consisted of filling the box as much as was possible with RTV, then covering both gasket faces on the junction (condulet) box lid with RTV and securing the lid. A final coating of epoxy-coal tar over the entire box completed the assembly.

The strain gauges were similarly doped upon being welded in place and covered with polyken tape prior to covering with the protective shells.

To complete moisture-proofing of the system, a tray of calcium chloride was placed in the bottom of each terminal box.

All components of the system were attached to the pipe by both polyken tape and metal strapping.

At each instrument station a pipe-to-soil potential lead was cad-welded to the line. At several points along the route, corrosion current points were also installed. All of these attachments were coated with the epoxy-coal tar dope and polyken tape.

Construction and instrumentation details are attached as are details of the original strain measurements, potentials and temperatures.

(d) Data and Data Processing

Arrangements have been made to supply the Northern Research personnel with the necessary instruments and cable connectors to allow them to take the strain and temperature readings. This will be attempted on a twice-monthly basis initially but this frequency may not be necessary.

Readings will be recorded on standard data sheets and forwarded for data processing. Results will be tabulated as point stresses at each gauge location.

The strain instrument has been insulated for winter operation and a standard reference for strain and temperature has been prepared for Northern Research.

(e) Future Project Activity

The following recommendations for future requirements are proposed:

1. a precise survey of the line tying in the various line markers, risers, etc. in the fall of 1967;

2. a re-survey in the hot summer months of 1968 to determine line movement;

3. an assessment of winter conditions along the line route in Feb. - March 1968;

4. a pipe-to-soil resistivity and general inspection of the line and installations in mid-1968;

5. a detailed inspection (metal loss and type of attack noted, pipe-to-soil potentials, resistivity and bacteria survey) of the Whitehorse - Skagway oil product line, the old Dawson City spiral welded water supply line and Norman Wells field equipment in mid-1968.

APPENDIX

The following items appear in the Appendix:

1. Installed Equipment Costs.
2. Arctic Pipeline Chainage and Line Markers.
3. Anchor Elevation Detail.
4. Thermistor Wiring Detail.
5. Strain Gauge Wiring Detail.
6. Installation Details Instrument Stations 1 - 11 inclusive.
7. Strain Gauge Calibration (Temp. vs Apparent Strain).
8. Thermistor, Strain and Pipe/Soil Data.

COLIN DUNCAN
Production Research &
Technical Service Dept.
Calgary - Alberta

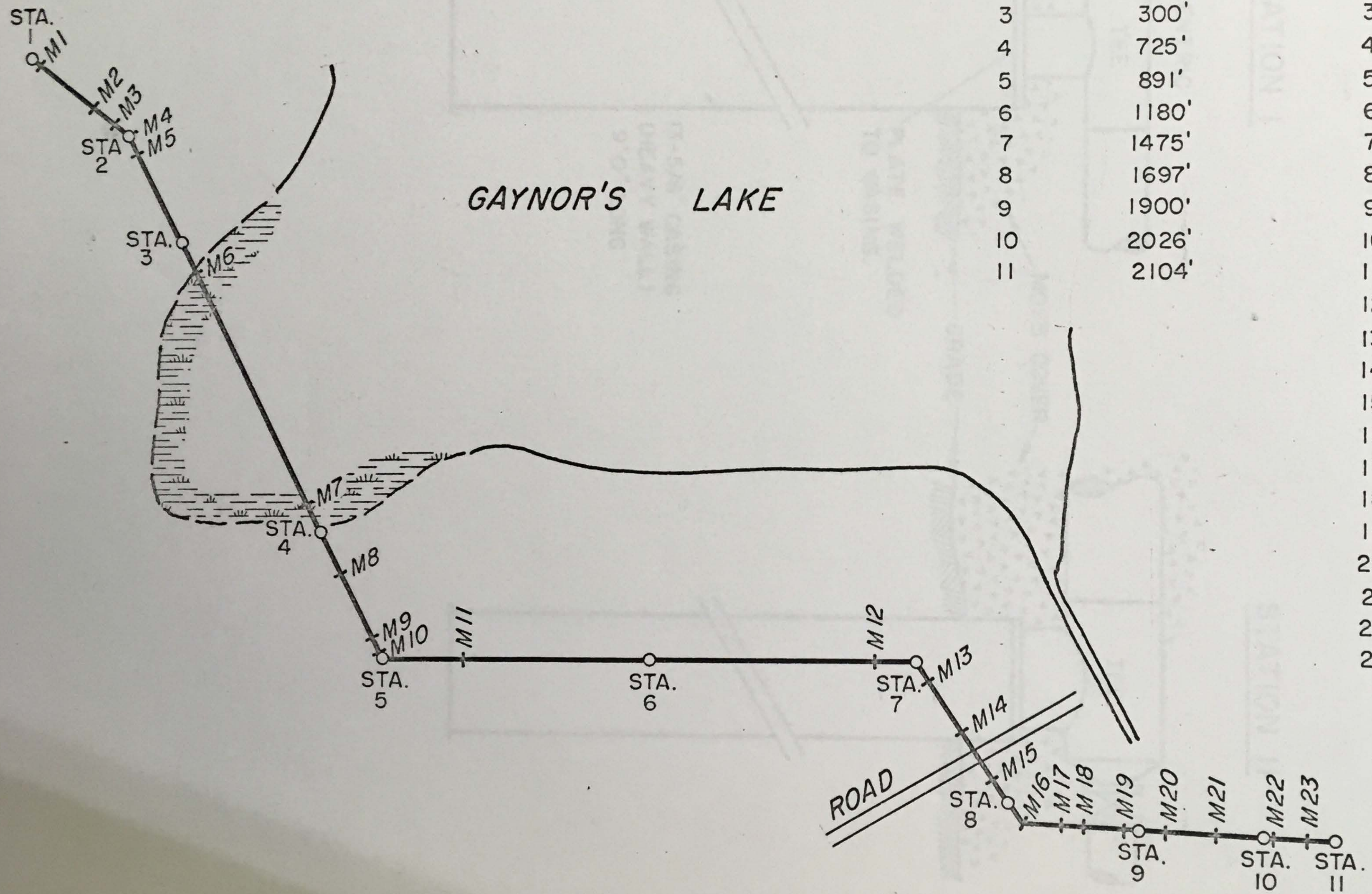
OCTOBER 17, 1967

INSTALLED EQUIPMENT COSTS
ARCTIC TEST PIPELINE

	Cost
1. Unitek Weldmatic Power Supply Welding Handpiece	$ 1,100*
2. Budd Portable Strain Instrument	900*
3. Microdot Strain Gauges	4,500*
4. Thermistors	450
5. Terminal Connectors	
a) Amphenol	260
b) Cannon	30
6. Conax Moisture Seals	260
7. Canada Wire Conductor	2,370
8. G.E. Condulets	160
9. Hammond Terminal Boxes	250
10. Instrument Poles	70
11. Miscellaneous tools and equipment	1,650
Total	$12,000

* Costs not yet finalized.

ARCTIC PIPELINE CHAINAGE AND LINE MARKERS



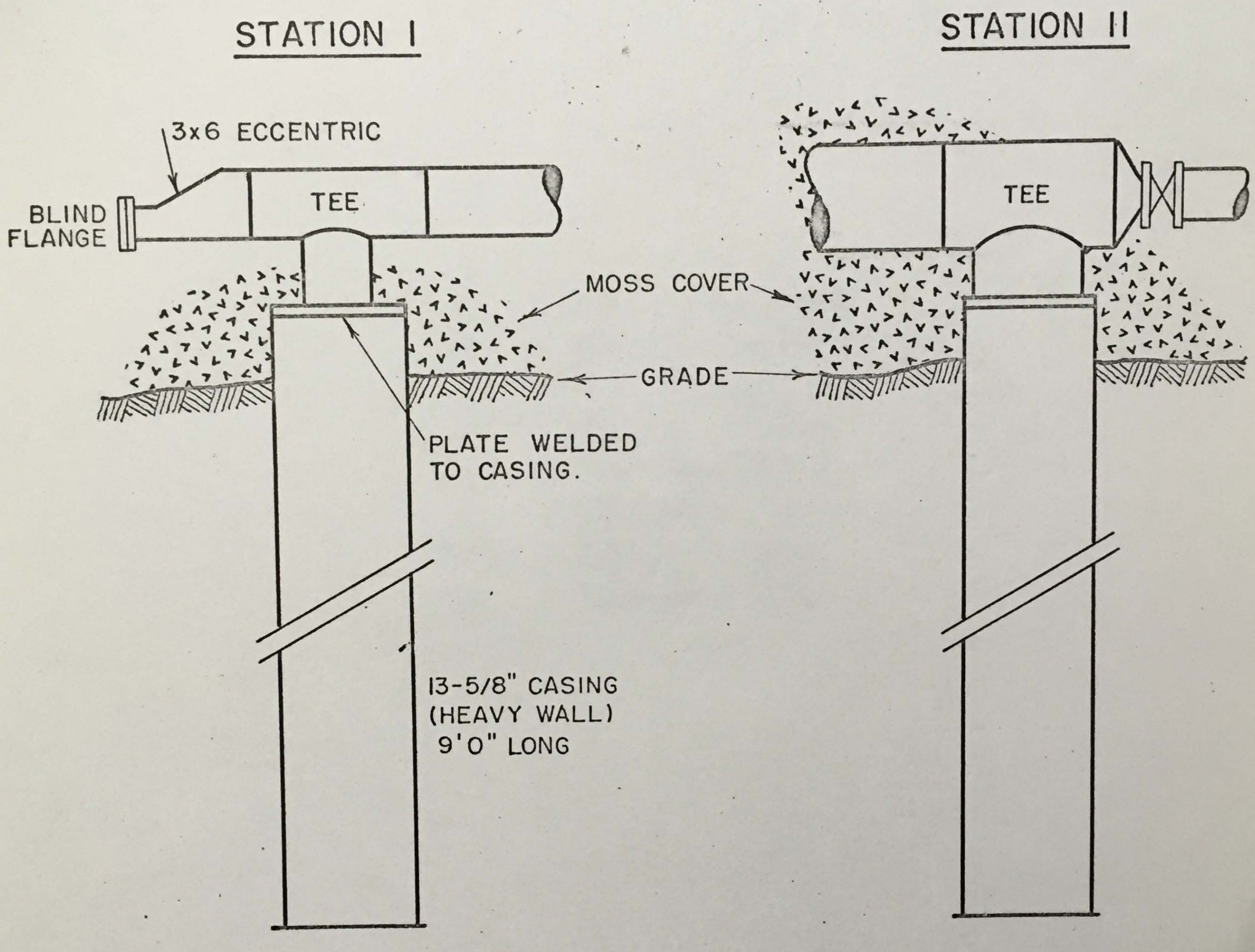
STATION

NUMBER	CHAINAGE
1	0
2	159'
3	300'
4	725'
5	891'
6	1180'
7	1475'
8	1697'
9	1900'
10	2026'
11	2104'

MARKER

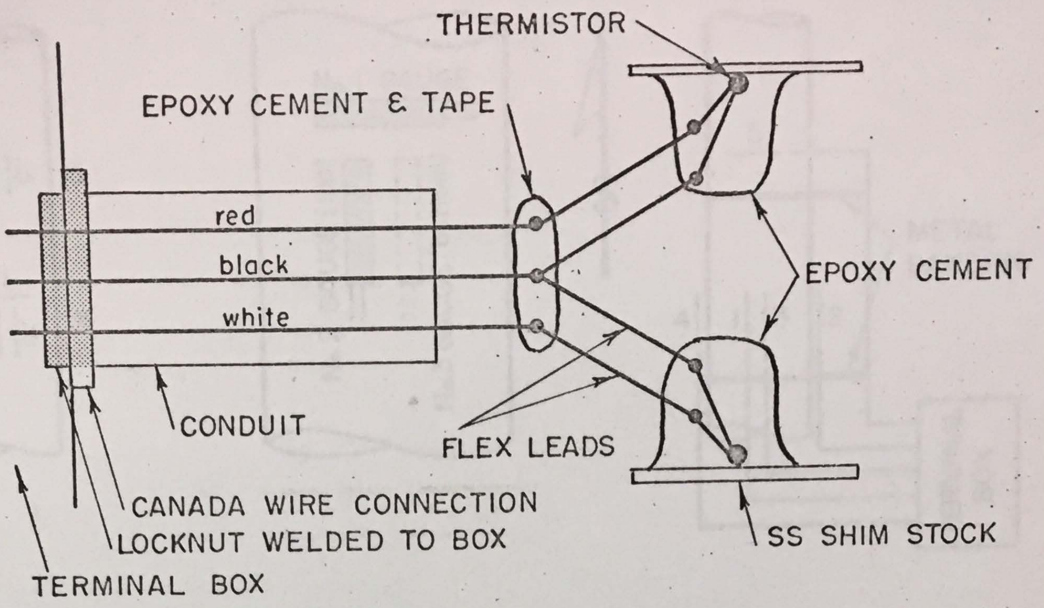
NUMBER	CHAINAGE
1	6'
2	100'
3	133'
4	159'
5	185'
6	350'
7	675'
8	774'
9	869'
10	888'
11	996'
12	1422'
13	1496'
14	1578'
15	1649'
16	1722'
17	1772'
18	1799'
19	1850'
20	1900'
21	1960'
22	2027'
23	2076'

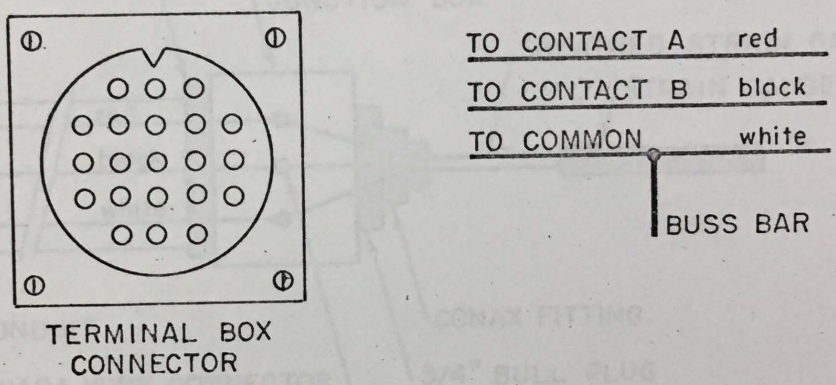
ANCHOR ELEVATION DETAIL

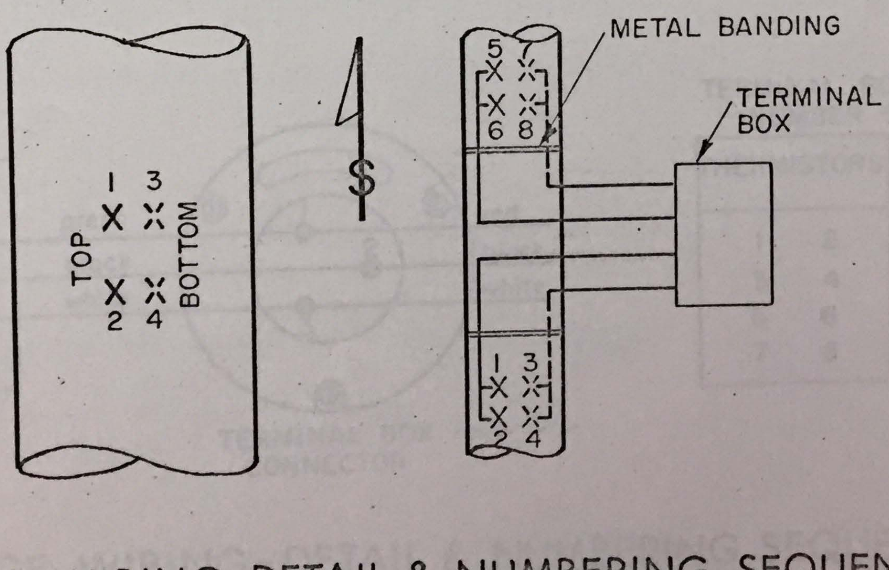


SYMBOLS FOR PIPELINE INSTRUMENTATION

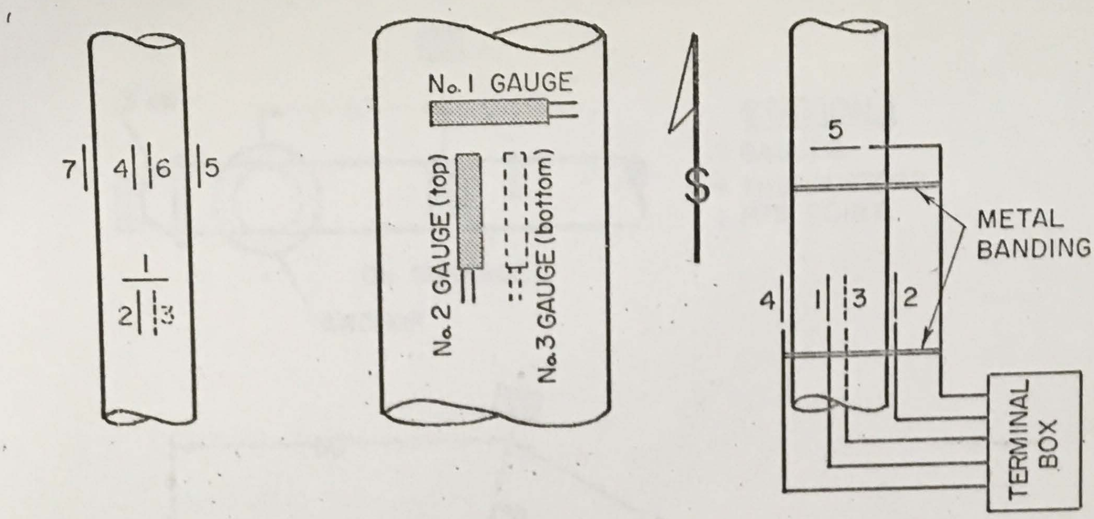
X	1 TOP THERMISTOR
⁙	1 BOTTOM THERMISTOR
—I	2 TOP GAUGES
---	1 BOTTOM GAUGE
—•	2 SIDE GAUGES
	1 P/S POINT
■—■	1 CURRENT POINT
□	1 TERMINAL BOX

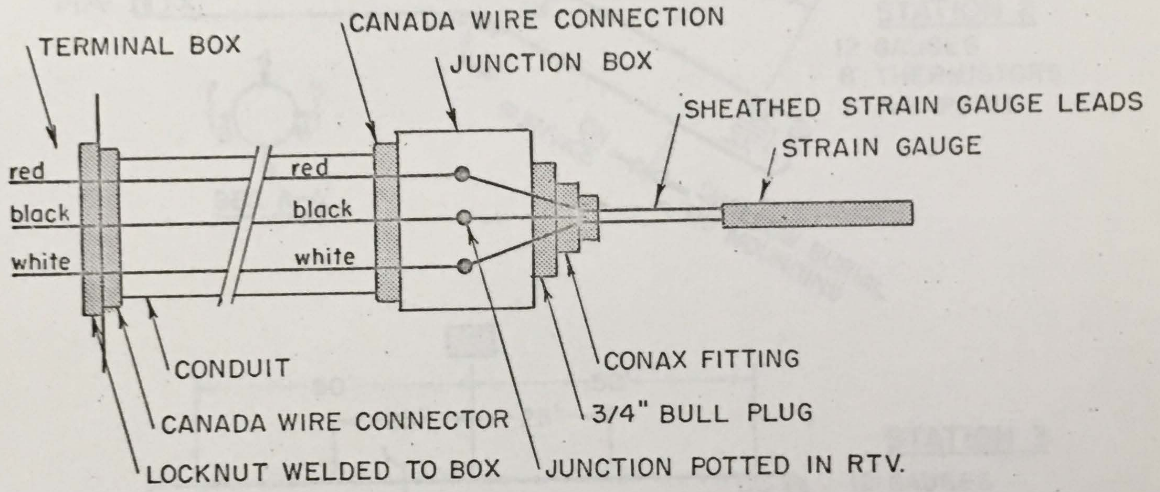


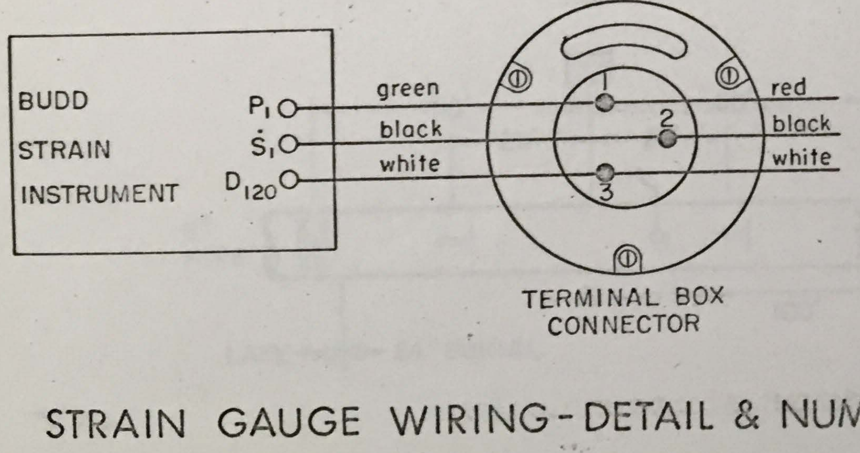




THERMISTOR WIRING DETAIL & NUMBERING SEQUENCES



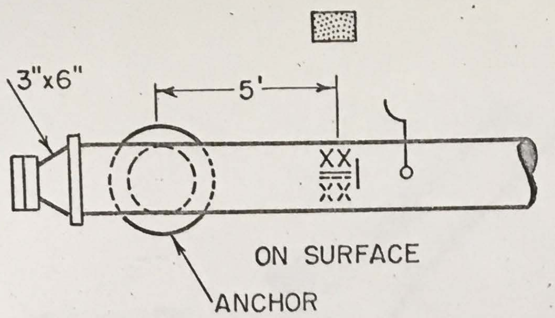




TERMINAL BOX CONNECTOR NUMBER SEQUENCE

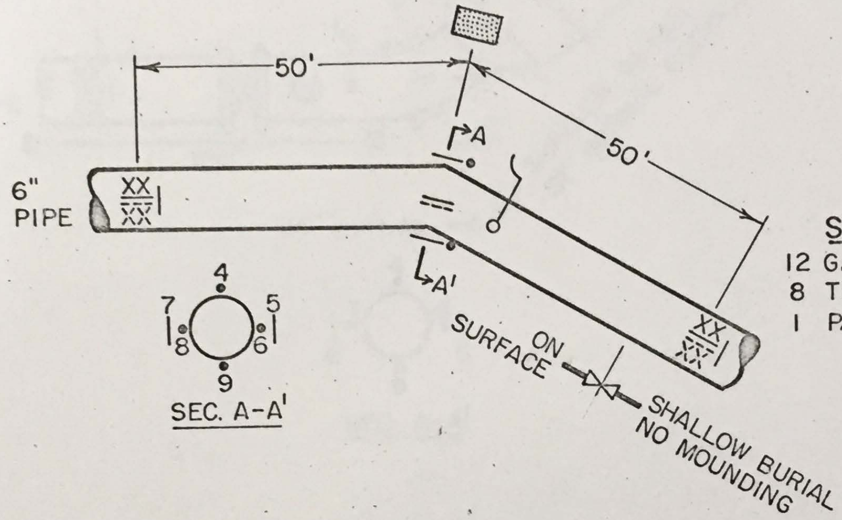
THERMISTORS		STRAIN GAUGES		
1	2	1	2	3
3	4	4	5	6
5	6	7	8	9
7	8	10	11	12

STRAIN GAUGE WIRING - DETAIL & NUMBERING SEQUENCES



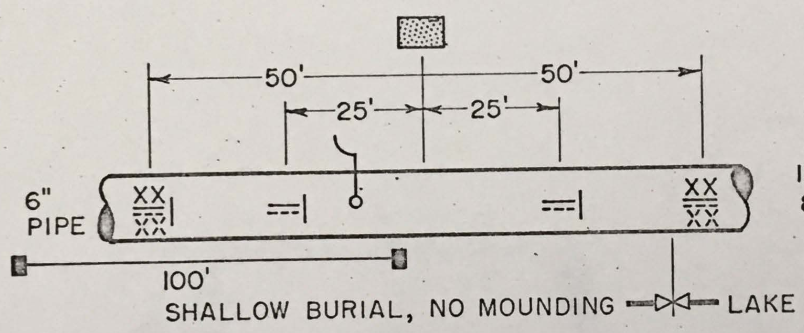
STATION 1

3 GAUGES
4 THERMISTORS
1 P/S POINT



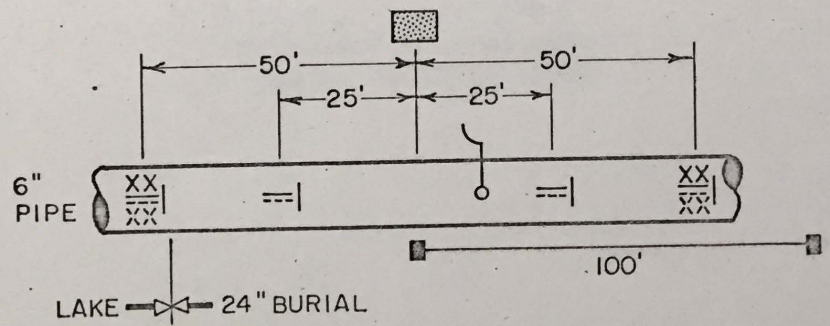
STATION 2

12 GAUGES
8 THERMISTORS
1 P/S POINT



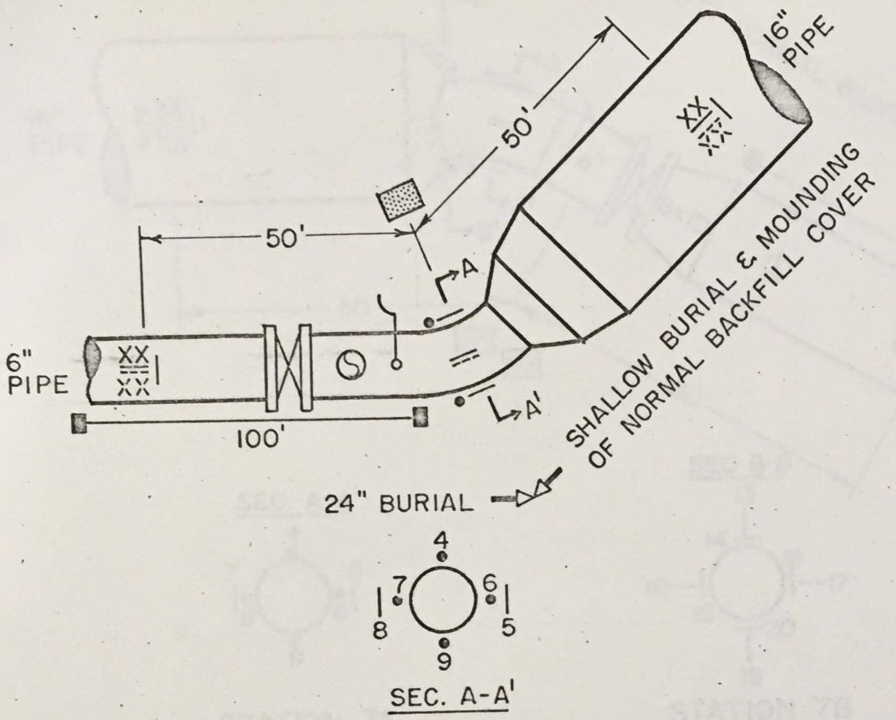
STATION 3

12 GAUGES
8 THERMISTORS
1 P/S
1 CURRENT POINT



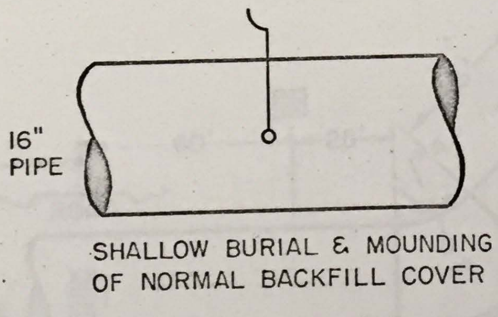
STATION 4

12 GAUGES
8 THERMISTORS
1 P/S POINT
2 SUBMERGED YELLOW JACKET PIPE SAMPLES FOR P/S READING.



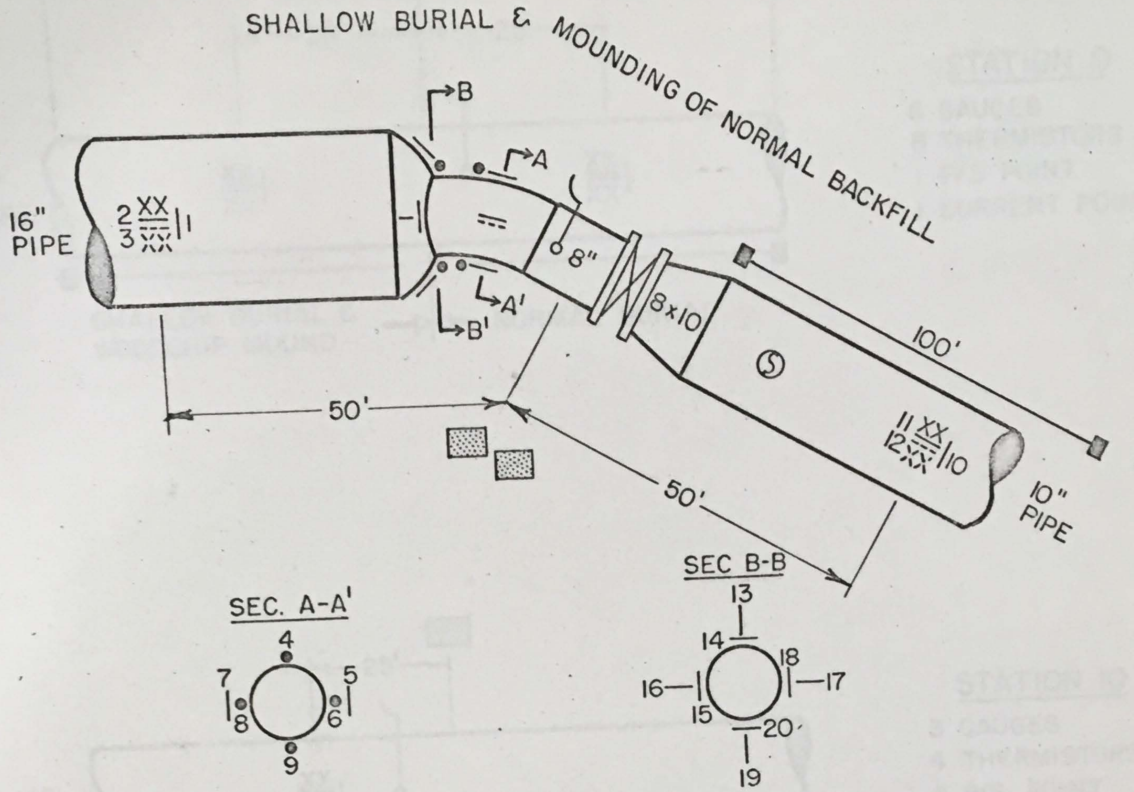
STATION 5

12 GAUGES
8 THERMISTORS
1 P/S POINT
1 CURRENT POINT



STATION 6

1 P/S POINT

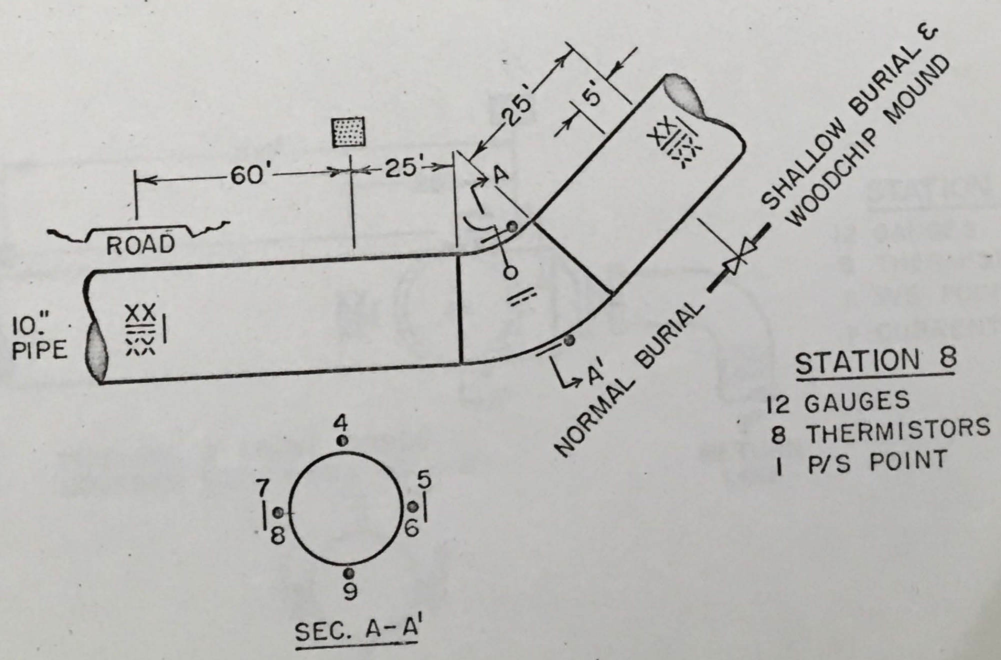


STATION 7A

12 GAUGES, No. 1 TO 12 INCL.
8 THERMISTORS
1 P/S POINT
1 CURRENT POINT

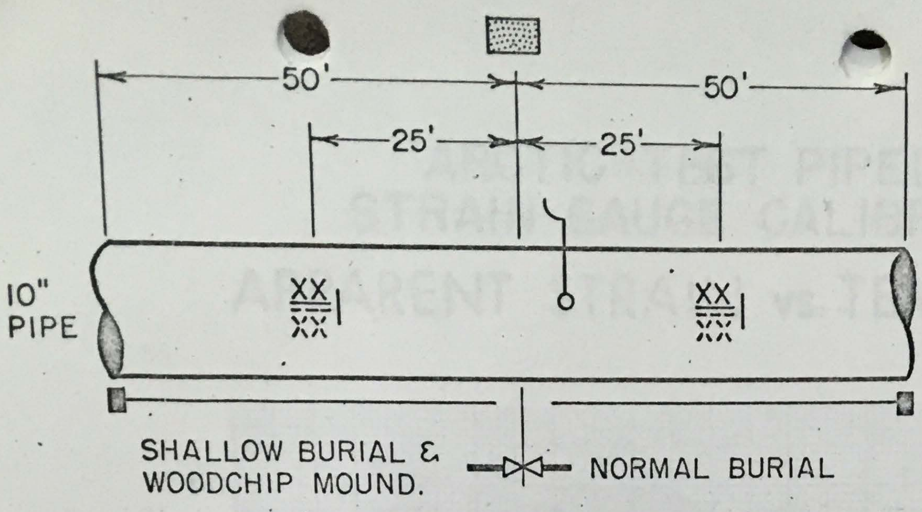
STATION 7B

8 GAUGES, No. 13-20 INCL.



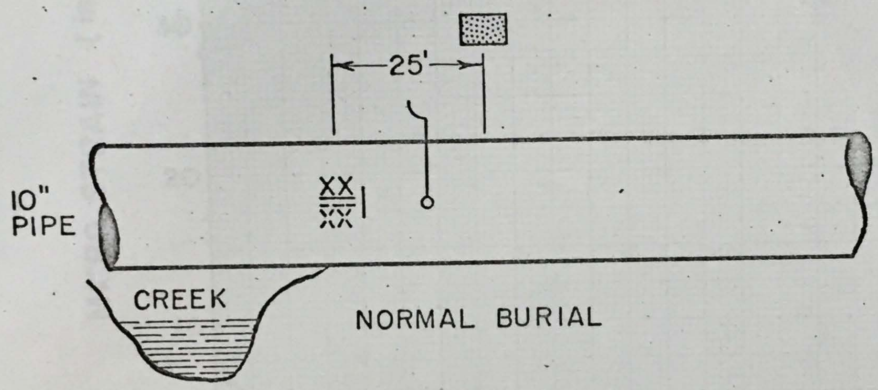
STATION 8

12 GAUGES
8 THERMISTORS
1 P/S POINT



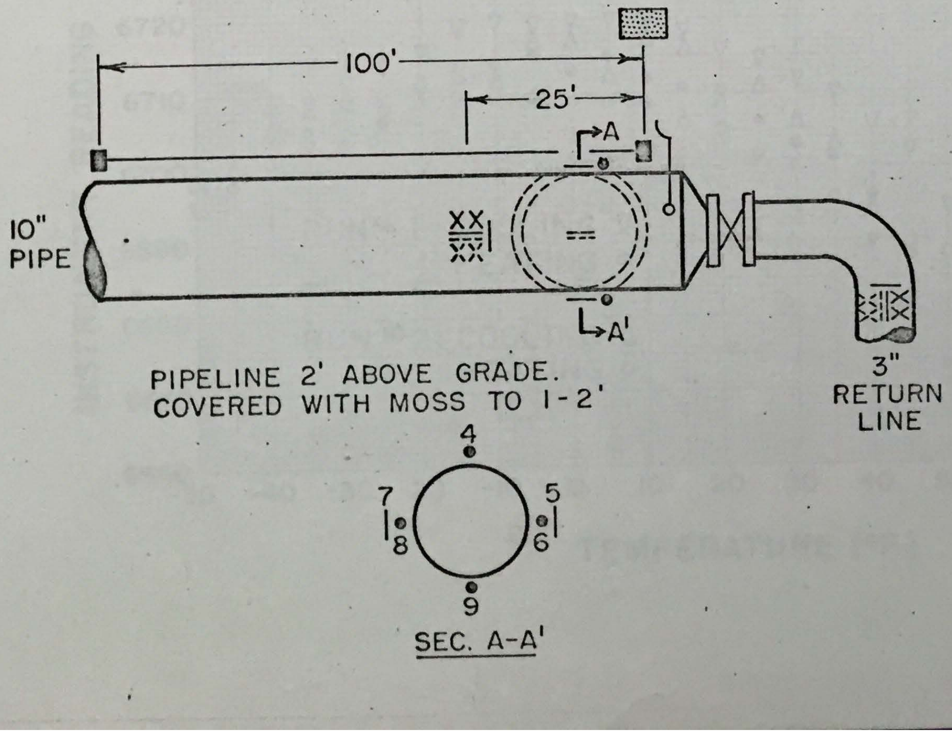
STATION 9

6 GAUGES
8 THERMISTORS
1 P/S POINT
1 CURRENT POINT



STATION 10

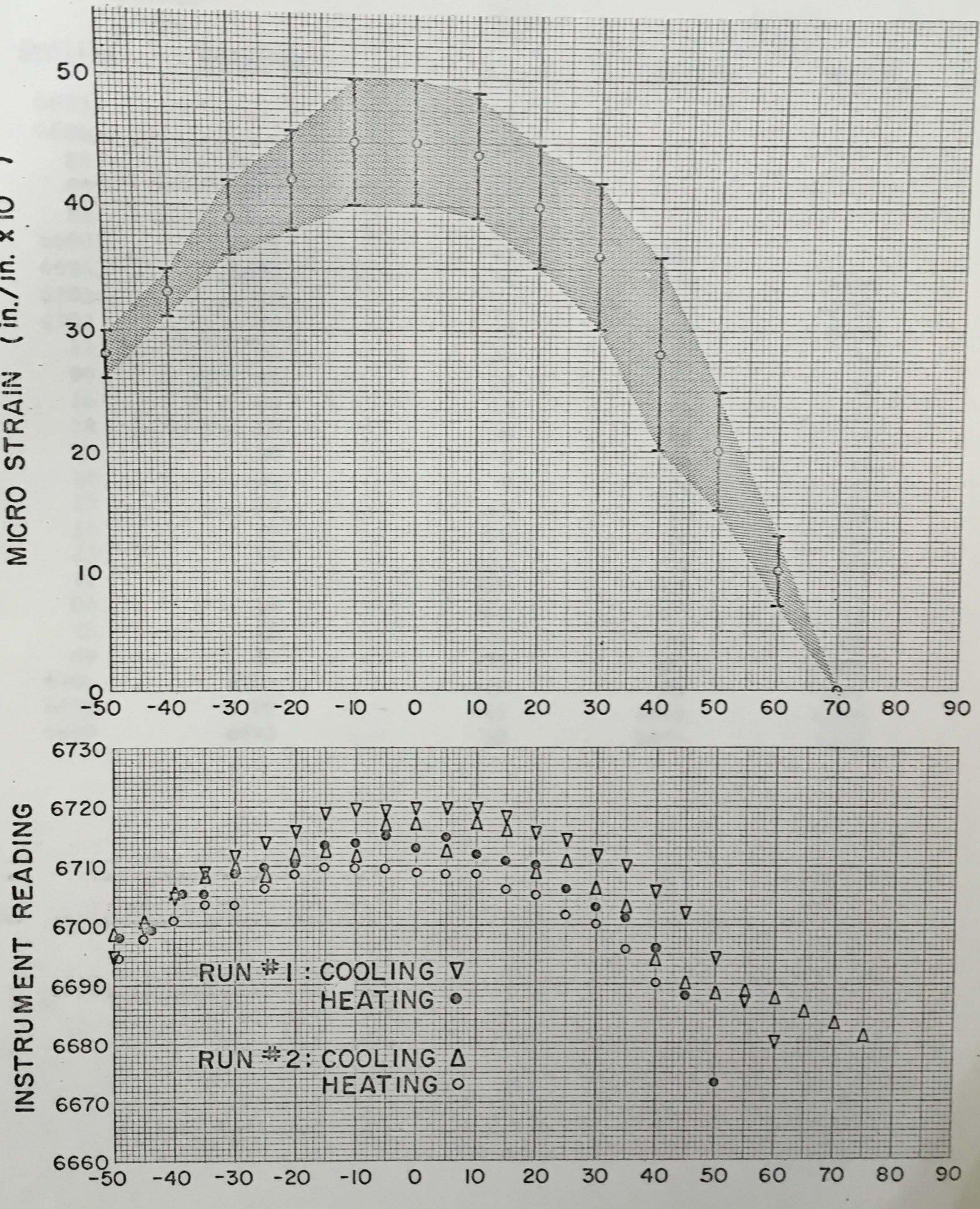
3 GAUGES
4 THERMISTORS
1 P/S POINT



STATION 11

12 GAUGES
8 THERMISTORS
1 P/S POINT
1 CURRENT POINT

ARCTIC TEST PIPELINE
STRAIN GAUGE CALIBRATION
APPARENT STRAIN vs. TEMPERATURE



STRAIN GAUGE CALIBRATION

TEMPERATURE VS APPARENT STRAIN

Cycle No. 1

Temp ^{o}F	Strain μ"/in Cooling	Strain μ"/in Heating
70	6683	
65	6686	
60	88	6680
55	89	6687
50	88	6695
45	6690	6702
40	6694	6606
35	6703	10
30	6707	12
25	11	15
20	09	16
15	16	19
10	18	20
5	13	20
0	18	20
-5	17	20
-10	12	20
-15	13	19
-20	12	16
-25	09	14
-30	10	12
-35	09	10
-40	6706	6705
-45	6701	6700
-50	6699	6695

Cycle No. 2

Temp ^{o}F	Strain μ"/in Cooling	Strain μ"/in Heating
70		
65		
60		
55		
50		
45	6681	
40	6690	6696
35	96	6701
30	6700	6703
25	6702	06
20	05	10
15	06	11
10	09	12
5	09	13
0	09	13
-5	10	15
-10	10	14
-15	10	13
-20	09	11
-25	07	10
-30	04	09
-35	04	6705
-40	01	6701
-45	6699	6699
50	6695	6698

ARCTIC TEST PIPELINE

THERMISTOR, STRAIN AND P/S DATA

Station No.	Gauge No.	Strain Reading Out of Ditch	Strain Reading In Ditch & Covered*	P/S M.V.	Thermistor Reading °F 1	2	3	4	5	6	7	8
1	01-01	0036	0612	570	44	44	44	44	44	44	44	44
	01-02	0875	1401									
	01-03	1994	1592									
2	02-01	1140	1190	620	44	44	44	44	44	44	44	44
	-02	8170	8133									
	-03	1680	1785									
	-04	1638	1500									
	-05	3529	3559									
	-06	3955	4069									
	-07	7950	9021									
	-08	2517	2506									
	-09	-1318	-1143									
	-10	-0459	-0504									
	-11	5332	5695									
	-12	1852	1545									
3	03-01	8486	8077	690	44	44	42	42	47	47	42	42
	-02	1329	-0100									
	-03	1192	-1524									
	-04	1370	1221									
	-05	2180	2060									
	-06	3814	3746									
	-07	0413	0642									
	-08	-1820	-2566									
	-09	-1810	-1157									
	-10	2409	2178									
	-11	2057	2229									
	-12	0182	-0053									

*All readings reported "In Ditch and Covered" were recorded on Aug. 21, 1967.

../2

Station No.	Gauge No.	Strain Reading Out of Ditch	Strain Reading In Ditch & Covered	P/S M.V.	Thermistor Reading °F 1	2	3	4	5	6	7	8
4	04-01	1942	1884	650	36	36	50	50	42	42	50	50
	04-02	-1033	-0670									
	-03	-0026	-0188									
	-04	5538	5689									
	-05	7627	6917									
	-06	6106	6693									
	-07	5573	5236									
	-08	0800	0726									
	-09	-2456	-2403									
	-10	4704	4591									
	-11	-2623	-1650									
	-12	-2704	-6560									
			Yellow Jacket 1	P/S = 870								
			Yellow Jacket 2	P/S = 790								
5	05-01	-0212	-0182	590	44	39	36	42	43	40	27	35
	-02	0308	Broken									
	-03	-1012	0895									
	-04	0530	0341									
	-05	9520	5313									
	-06	1445	1324									
	-07	7417	7845									
	-08	-6636	-6540									
	-09	-2376	-2506									
	-10	-2132	-2202									
	-11	-0614	Broken									
	-12	-0915	-1053									
6	--	--	--	590								
7a	07-01	-2282	-2255	590	42	42	44	45	42	42	45	40
	-02	0386	2035									
	-03	5995	6192									
	-04	1696	2252									
	-05	1690	0414									
	-06	12670	11978									
	-07	2630	3021									
	-08	1114	0304									
	-09	2839	2704									
	-10	5117	5115									
	-11	1160	0856									
	-12	4460	4178									
7b	07-13	-0392	0230									
	-14	-1471	-0654									
	-15	3493	3378									
	-16	-2010	-2028									
	-17	0358	-1559									
	-18	2968	2734									
	-19	2312	1757									
	-20	2702	2340									

../3

Station No.	Gauge No.	Strain Reading Out of Ditch	Strain Reading In Ditch & Covered	P/S M.V.	Thermistor Reading °F 1	2	3	4	5	6	7	8
8	08-01	6336	6356	570	45	45	43	43	38	38	34	34
	-02	3465	3517									
	-03	2268	2163									
	-04	4227	3762									
	-05	4490	Broken									
	-06	5236	7340									
	-07	4461	4889									
	-08	2411	2700									
	-09	0388	0272									
	-10	3236	3142									
	-11	7338	7314									
	-12	1888	1964									
9	09-01	2723	2506	610	37	37	41	41	37	37	37	36
	-02	-2488	-2155									
	-03	1657	1087									
	-04	4090	4012									
	-05	1856	1900									
	-06	1864	-1510									
10	10-01	2552	2497									
	-02	9596	9580									
	-03	0166	-0097	--	--	--	--	--	--	--	--	---
11	11-01	1138	1236	600	43	43	42	42	50	50	50	50
	-02	0360	-0130									
	-03	2165	2626									
	-04	1713	1555									
	-05	2426	2410									
	-06	-1520	1602									
	-07	2231	2154									
	-08	0205	0334									
	-09	0925	0205									
	-10	1310	1912									
	-11	0492	0922									
	-12	-2941	-3235									

September 28, 1967

Re: Presentation - Technical Meeting - N.Y.
Pipe Line Research Project #483.

916466

Mr. V.C. Larson
Imperial Oil Limited
Western Region Producing Department
339 50th Avenue South East
Calgary, Alberta.

Attention Mr. R.A. Hemstock/BCM

Dear Sir:

Further to our discussion on the presentation to be made on Project #483 at the forthcoming meeting in New York on October 11th and 12th, this was also briefly reviewed with Mr. Colin Duncan at the meeting held in Edmonton last week.

It is understood that you will be covering the topics on soil temperature and oil rheology generally as presented in the summary sent to this office and thence to New York. It is anticipated that the current interest in oil yield strength, flow behaviour and methods of analyzing and predicting this may elicit considerable discussion at the meeting.

Regarding the test installation in the Inuvik area it is suggested that you should plan to present the portion related to the stress analysis on the pipe line, particularly with regard to the instrumenting of the system. The following "areas" are suggested for consideration in your presentation:

(a) Gauge selection and use
(b) Point of gauge installation - reason for selection, etc.
(c) Typical "station" on the test site and installation details
(d) Plans for test readings, etc. in 1967-68 programme.

Please feel free to modify the above "areas" or, if you wish, some coverage by the writer's presentation of part of the above items, this could be made. At any rate there will be some overlays but the general areas that it is planned to cover in our presentation are:

(a) Purpose of test installation
(b) Site selection - reasons and limitations
(c) Review of layout and plans
(d) Planning, shipping, equipment, labour, timing, etc.
(e) Installation work - special problems, etc.
(f) Plans for 1967-68 follow-up work.

Mr. V.C. Larson/Calgary. September 28, 1967

It is hoped that the above decision will fit in with your plans reasonably well, however, it is not intended to be too fixed.

As discussed with Mr. Duncan, our estimate for the 1968 anticipated budget was put in at $35,000.00. This was based on $10,000.00 for this office and $25,000.00 for your office, to cover the three phases of rheology, temperature probes and installation work and it was felt this included a reasonable contingencyamount. We would like to review this with you prior to the meeting.in New York and, it was understood you would be assessing your anticipated expenditures with Mr. Duncan after last week's meeting.

We have attached a copy of our Steering Committee review sent to New York last week along with your report. As you will note, it has been kept quite general.

When we have more details prepared on our presentation plans we will discuss this with you by 'phone. If any questions arise in the meantime, please do not hesitate to call.

Yours very truly,

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.

Encls.

EDMONTON JOURNAL
SEP 23 1967

Experimental Pipeline Laid

By ART SORENSEN
Of The Journal

INUVIK — An experimental oil pipeline has been laid in the vicinity of this Arctic community.

Imperial Oil Limited completed the job in conjunction with the Inuvik Research Laboratory.

Richard Hill, laboratory manager, says the 2,400-foot line has been instrumented to record temperatures and stress over the next three to four years.

The line starts in high dry ground, drops to a wet marshy area and then passes through a lake.

Mr. Hill says about 400 feet of the line pass through a massive sheet of ground ice. Provision is made for pumping oil through parts of the line.

Other parts have been left on the surface, insulated with such materials as moss and wood chips.

"Instrument readings and pipeline movements will be noted by the research centre on a regular basis," Mr. Hill says.

The project is expected to point out obvious problems that can be avoided if, and when, a full-scale pipeline is constructed in the Arctic.

An added purpose of the line is to evaluate and assess techniques of laying a pipeline across Arctic terrain.

John Lyle of Imperial's pipeline division is in charge of the project and Alec Hemstock of Imperial's Calgary research laboratory is setting up the instrumentation.

V. Taylor
P. White
K. Sniply ✓

D.R.M.
M.W.C.
W.G.C.

9.666 E

P/L DIVISION
FILE No. ~~[illegible]~~
SEP 28 1967

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WJK	✓		[illegible]
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DAILY NEWS SUMMARY

Imperial Oil Limited

This summary is to help management keep informed about current items in the press that may bear directly or indirectly on company and industry affairs. Authority for any item summarized rests with the publication from which it is taken. The fact that a summary appears does not imply either comment or confirmation by Imperial Oil Limited. To borrow clippings, 'phone Public Relations Department, (local 870). Please order by date and item number. To change mailing address, 'phone local 895.

Thursday September 28, 1967

1. GERMAN SCIENTISTS CLAIM NEW PHOTOGRAPHY-COMPUTER SYSTEM WOULD AID PROSPECTING

- Scientists fron West German Technical University of Karlsruhe have described new system of aerial photography to delegates attending International Electronics Conference and Exposition in Toronto. Method of photo interpretation, working in collaboration with a computer, is claimed to aid discovery of oil and mineral deposits. Equipment has been developed over 3-year period under sponsorship of West German Defence Ministry and will not be fully operational until next spring. Details of system are freely available, however, and the university is prepared to accept commercial projects when first stage is completed. Cost is said to depend on area surveyed.

Globe & Mail, September 27

2. IMPERIAL OIL LAYS EXPERIMENTAL PIPELINE IN ARCTIC

Inuvik - Imperial Oil, in conjunction with Inuvik Research Laboratory, has laid 2,400-foot experimental oil pipeline in vicinity of Inuvik. Line starts in high, dry ground, drops to wet marshy land and passes through a lake and a massive sheet of ground ice. Parts have been left on surface, insulated with such materials as moss and wood chips. Instrument readings and pipeline movements will be noted by research centre on regular basis over 3-4 years. Object of recordings is to evaluate and assess techniques of laying pipelines across Arctic terrain.

Edmonton Journal, September 23

3. COMPUTER-CONTROLLED SYSTEMS TO FACILITATE MOVEMENT OF SASKATCHEWAN CRUDE

— W. R. Scrimes, regional electrical engineer of Imperial Oil Ltd., has predicted that Regina-based computer-controlled systems will facilitate movement of oil from wells to storage by 1970. He warned that if industry was to make proper use of computers, it must eliminate their "tin god" image, and pointed out that they would eliminate human error and worker monotony, reduce operating expenses and increase production.

Regina Leader-Post, September 21

4. TEXACO EXECUTIVE CRITICIZES GASOLINE MARKETING PRACTICES

- Albuquerque - A.M. Card, Texaco vice-president for domestic sales, has sharply criticized oil industry for some of its gasoline practices and warned that they could lead to restrictive action by U.S. government. In particular, Mr. Card said he agreed with recent report of Federal Trade Commission in its criticism of such practices as selling gasoline to private-brand service station chains at lower prices than to a company's own branded dealers; selling of "subregular" gasolines at prices lower than those of major brands of regular grade; operation of company-owned stations in competition with those of independent dealers of same company; and interfering with independent dealer decisions on retail prices. He also attacked trend to cash-giveaway games, stating that it would be far better for promotions to be concentrated on giving consumers top quality products and efficient and complete services which were of "real" value.

Wall Street Journal, September 25

5. SURVEY SHOWS MOTORISTS FAVOR TRUCK-STOP SERVICE STATIONS

- Survey conducted by American Oil Co. has shown that motorists like to patronize truck-stop service stations because they expect them to be above average in facilities, services, products, experienced personnel and fast service.

Journal of Commerce, September 22

6. QUEBEC EXPECTS TO USE ALL CHURCHILL FALLS POWER

Boston - Hydro-Quebec has advised three New England utilities supplying more than half of New England electric power that it now expects it will itself need all of 6,000,000 horsepower which will be derived from Churchill Falls hydro-electric power project, starting in 1972, and that long-term resale of any part of Labrador power to U.S utilities would therefore not be in its interest. Newfoundland Premier Smallwood has predicted that no power from Churchill Falls project will be exported from Canada because of fast growth of power consumption in Canada.

Toronto papers, September 27

7. CANADIAN EDUCATION MINISTERS TO ESTABLISH COUNCIL OF EDUCATION MINISTERS

Regina - Canadian Education Ministers have agreed to establish a Council of Ministers of Education under chairmanship of Ontario Education Minister William Davis, who described Council as "the closest we can constitutionally come to a national office of education."

Toronto papers, September 27

8. COMMONS APPROVES SETTING UP OF CANADA MANPOWER AND IMMIGRATION COUNCIL

Ottawa - Commons has given approval in principle to bill providing for establishment of 16-member Canada Manpower and Immigration Council, as well as 4 specialized 12-member advisory boards and any other advisory boards which Manpower Minister Marchand feels are needed, plus regional and local advisory committees.

Toronto papers, September 27

9. SEAWAY TO BE CLOSED ON DECEMBER 6

Ottawa - St. Lawrence Seaway Authority has announced that official closing date for Montreal-Lake Ontario section of St. Lawrence Seaway will be December 6, although navigation will be extended on day-to-day basis beyond that date until December 15, weather permitting. Official closing dates for Sault Ste. Marie Canal and Welland Canal are December 12 and 15, respectively.

Toronto papers, September 27

LATE NEWS

1. CANADIAN PAYMENTS DEFICIT CUT BY $216 MILLION

Ottawa - Dominion Bureau Statistics reports that Canadian balance-of-payments deficit totalled $555 million at mid-year, compared with $771 million at mid-1966. Deficit for second quarter of 1967 was cut from $375 to $249 million mainly by foreign tourist spending. 64% of improvement at mid-year was attributed to merchandise trade, 58% of it to transactions with U.S.

Globe & Mail, September 28

2. NHA RATE LIMIT RAISED TO 8 1/4%

Ottawa - Federal government has announced increase in maximum interest rate on National Housing Act home-ownership and rental loans to 8 1/4 % effective October 1. Action is move to draw more private lenders into housing field. Labor Department spokesman says it is unlikely rate will increase by full percentage point because lenders consider guarantee of payment in the act is worth about 0.75% of total rate. NHA rates are traditionally about 1% lower than those for conventional first martgages, which are expected to rise by that amount. Apparently inevitable rise in housing costs will be reflected in national cost-of-living index, on which pay of hundreds of thousands of Canadians depends.

Globe & Mail, September 28

3. SHELL REPORTS DRY HOLE OFF B.C. COAST

Victoria - Shell Canada has abandoned its first exploratory well in waters off B.C. coast and reports that it failed to produce oil. Work is proceeding on second well, which reached depth of 6,535 feet by September 1.

Globe & Mail, September 28

September 28, 1967

Re: Arctic Pipe Line Meeting

File: 9.666E

Mr. E.W. Christian
Imperial Pipe Line Company Limited
11160 Jasper Avenue
Edmonton, Alberta.

Attention Mr. J.E. Lyle

Dear Sir:

We wish to thank you for the excellent review of the test installation planning and work given last week. As discussed, we would like to have a detailed account of the overall undertaking to provide information on planning, scheduling, transportation and installation with particular emphasis on those items that created problems or potential areas of future problems.

It is agreed that a detailed survey should be made of the installation and we will leave this matter for you to arrange. Perhaps it can be co-ordinated with another trip if the Company 'plane is involved or the men can go in via commercial service.

We will await your slides of the construction with a list of notations to readily identify and describe them. As you know, it is planned to use these at the presentation in New York on October 10th to 12th so we would like them as early as convenient for you.

The aerial photograph was received from your office and we would like a vu-graph made from the negative of that photograph if you can get this done. This would be useful adjunct for the presentation.

The writer will be in the office October 5th and 6th if there are any questions regarding the above.

Yours very truly,
K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.

9.666E

CROSS REFERENCE FILE FORM

SEE LETTER TO - C. Carlisle

SEE LETTER FROM - R.A. Hemstock

DATED - Sept. 19/67

FILED - 9.666

SUBJECT

1967 Pipe Line Steering Com. Mtg

Encl. summary work re

Artic P/L Design and

Construction Problems

MEMORANDUM

To Mr. J. E. Lyle

From E. W. Christian

Date August 14, 1967

Our File 37.37

During a telephone conversation today, Mr. K. R. Shipley expressed some concern about supplying data obtained from our Arctic Research Project to the National Research Council and to the Department of Indian Affairs and Northern Development, as noted in Mr. G. H. Caldwell's letter of July 24, which was forwarded to him with your letter of July 28.

He referred to the confidential nature of Esso Research projects and requested that the data be supplied only with the understanding that it will not be made available to Imperial's competitors or to the general public.

Perhaps upon your return from Inuvik you can bring him up to date concerning any discussions which may have been held with Government departments with respect to the confidential nature of this information.

EWC/McB

c.c. - Mr. K. R. Shipley

P/L DIVISION
FILE No. 9.666E
AUG 17 1967

	NOTE	ACT	INITIAL
KRS	✓		[illegible]
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DATE ANS'D 16 38

FORM 71324-A-E.P.L.

THE IMPERIAL PIPE LINE COMPANY LIMITED

2858-1 RC

August 15, 1967

File 9-666E

Mr. E.W. Christian
Imperial Pipe Line Company Limited
11160 Jasper Avenue
Edmonton, Alta.

Dear Sir: Arctic Pipe Line Project

Confirming our telephone conversation in connection with credit for land maintenance, we suggest that you check with Mr. Caldwell, Chief, Resource Management Division, in regards to the contents of the report which they and the National Research Council require. I understand that under certain conditions, information such as this will be kept confidential and not released to industry or the public. However, we should be given this assurance; otherwise we should not accept the credit from the Government.

We would appreciate hearing from you after you have had further contact with Mr. Caldwell.

Very truly yours,

KRS:g

August 2, 1967

Re: Arctic Pipe Line Research Program

File: 9.666E

Mr. S.E. Ewens
Tax Department
Building.

Attention Mr. D.A. Macintyre

On July 28 you returned to us, along with your letter, the information concerning proposed credit for research work being undertaken in the Arctic. It is understood there may be some conflict regarding I.O.L. and I.O.E.L. participation in this work and that you are following this matter further.

We have attached hereto, a further letter from our Edmonton office with a reply from the Department of Indian Affairs and Northern Development of the Federal Government. You will note that the Department has approved, in principlè, our claim and appear anxious to foster this type of work.

As we understand it, this does not provide any monetary refund to our Pipe Line Research Program but would constitute a corporate gain since it can be allocated to Producing Department permits.

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.

Encls.

IMPERIAL OIL LIMITED

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION
E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE, EDMONTON, CANADA

Confidentiality 33

July 28, 1967

Our File 37.37

Mr. K. R. Shipley (WJK),
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

Credit for Land Maintenance
Arctic Pipelining

For your information and consideration, attached is a copy of a letter from the Department of Indian Affairs and Northern Development, dated July 24, 1967.

This letter gives approval in principle that the work on the Arctic Pipeline Project can be allocated to permits in Group 185, and outlines the conditions on which this credit can be claimed by I.O.E.

Yours very truly,

E. W. CHRISTIAN

John E. Lyle
J. E. Lyle

JEL/McB
Enc.

P/L DIVISION
FILE No. 9.666E
JUL 31 1967

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DATE ANS'D 15/9

10 copies ...

Department of Indian Affairs and Northern Development | Resource and Economic Development Group | Ministère des Affaires indiennes et du Nord canadien | Bureau des ressources et du développement économique

Imperial Oil Enterprises Ltd.,
11160 - Jasper Avenue,
Edmonton, Alberta.

Ottawa 4, July 24, 1967.

F.A.L.M.			
			L
JUL 27 1967			
E.W.C.	J.D.J.	R.M.R	R.L.S.
Ewl			

our file/notre dossier
your file/votre dossier
date

971-32-0

Attention: Mr. S.G. Lange

Dear Sir,

Pipeline Research Project - Inuvik Area

We are pleased to learn that the Pipeline Division of Imperial Oil Ltd. will undertake an experimental pipeline project about two miles south of Inuvik in proximity to the airport road. Projects of this kind are essential in new areas and under different climatic conditions to more fully understand engineering problems associated with man made structures in perma-frost regions.

Pursuant to Section 48 (2) of the Canada Oil and Gas Land Regulations we are pleased to approve in principle that expenditures associated with the subject pipeline project can be allocated to permits in Group 185. Though the information collected will be made available to the National Research Council by your Company, this Department will also require three copies of the report containing the basic engineering data. As in the case of geological reports we will not require your interpretation of this data.

N.B.

When submitting reports or statements of expenditures pursuant to their program please quote our project No. 7-19-7-67-3.

Yours very truly,

J. Holwoodward

for G.H. Caldwell,
Chief,
Resource Management Division.

IMPERIAL OIL LIMITED

Esso

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION

E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE, EDMONTON, CANADA

July 28, 1967

Our File 37.37

Mr. K. R. Shipley, (WJK)
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

Arctic Pipelining - Research Project #483

Further to our communication of July 27, attached is a copy of Mr. Murray's official communication concerning the rental rates that the Regional Drilling Department will charge the research project. This confirms the notations made on the previous attachments.

Yours very truly,

E. W. CHRISTIAN

John E. Lyle
J. E. Lyle

JEL/McB
Enc.

P/L DIVISION
FILE No. 9.666E
JUL 31 1967

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WJK	✓		WJK

DATE ANS'D 15/8

IMPERIAL OIL ENTERPRISES LTD

11650 - 142ND STREET, EDMONTON, ALBERTA

REGIONAL DRILLING DEPARTMENT

V. H. HUNTER, MANAGER

F.A.L.M. | E.L. L
JUL 27 1967
E.W.C. | J.D.J. | R.M.R. | R.L.S.

July 26, 1967.

File: 15.0710

Mr. John E. Lyle,
Imperial Pipe Line Co. Ltd.,
11160 Jasper Avenue,
Edmonton, Alberta.

Dear Sir:

Re: Arctic Pipeline Research Project - Rental Rates on Equipment - Regional Drilling Department

Attached is a list of rates applicable to equipment supplied by the Regional Drilling Department for the above project. All rates quoted are less than those charged by commercial rental service companies for similar equipment. Our charges will commence August 3, 1967, and will continue until the job is finished and either the equipment is returned to Arctic Red River or stacked at Inuvik.

Your project will be charged labour, fuels, oils, greases, and repairs associated with any of this equipment while used on the project.

These rates were compiled after intensive study of expected operating conditions, availability of similar equipment at Inuvik, commercial rates at Inuvik, and our "break-even" point to meet bare daily expenses. They represent a minimum charge to the project.

Yours very truly,

V. H. Hunter

ASM/mb
Encl.

EQUIPMENT RENTAL RATES
ARCTIC PIPELINE RESEARCH PROJECT

2 Only	10' x 40' Sleepers	Each $30.00/day
2 Only	Welder, Electric	$9.00/day
1 Set	Welding Equipment, Acetylene	$6.00/day
1 Only	Air Compressor & Jack Hammer	$22.50/day
1 Only	Wood Chipper	$7.50/day
4 Pcs.	Rig Matting	N/C
1 Only	Sleigh	N/C
1 Only	Winch Line (Spare)	N/C
300'	Cable, Soft Lay, 3/4"	N/C
1 Only	D7 Cat w/Poles & Ripper	$50.00/day + $15.00/Operating Hour
1 Only	Track Unit, Nodwell w/Poles	$50.00/day + $15.00/Operating Hour
1 Only	Power Wagon 4x4 Crew Cab	$25.00/day

TAX DEPARTMENT

MEMORANDUM

July 28, 1967

Re: Arctic Pipeline Research Project

Our Files: D-142
D-101-67
D-301-67

Mr. K.R. Shipley
Building

Attention: Mr. C. Carlisle

We are returning the original copy of a letter, July 20, 1967 to you from Mr. E.W. Christian. This indicates that IOEL has applied to the Department of Indian Affairs and Northern Development for permission to apply costs incurred by IOL on a northern pipeline research project against IOEL's work commitments under certain northern exploration permits.

We will be giving further consideration to the implications of this arrangement in terms of the relationships which should be maintained between IOL and IOEL.

With respect to the last paragraph of Mr. Christian's letter it would appear to us that the work to be performed would constitute research and that the costs could be included in Imperial's claim for IRDIA grants.

Claimed on a Corporate basis
cash subsidies
Capital 25% grant
25%. Tax free

S.E. EWENS

DAM:f
Attach.

By: D.A. Mauntz

P/L DIVISION
FILE No. 9.666E
JUL 28 1967

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DATE ANS'D 1503.

IMPERIAL OIL LIMITED

Esso

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION

E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE, EDMONTON, CANADA

July 27, 1967

Our File 37.37

Mr. K. R. Shipley,
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir: Attention Mr. W. J. Keys

Re Arctic Pipelining,
Research Project #483

On the morning of August 26, 1967, a meeting was held with I.O.E. Regional Drilling representatives to discuss the costs and plans for the Arctic Pipelining project. The attached "Shipping Charges" and "Equipment Rental Rates" were submitted and discussed. One compromise was worked out (Ref. note on sheet) and the rates tentatively accepted subject to your approval.

If you wish further information, please phone July 31 or August 1 and discuss the items you may question.

Yours very truly,

E. W. CHRISTIAN

J.E. Lyle
McB

J. E. Lyle

JEL/McB
Encs.

P/L DIVISION
FILE No. 9.666E
JUL 28 1967

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DATE ANS'D 1509

- d r a f t -

July 26, 1967

File: 15.0710

Mr. John Lyle

Re: Arctic Pipeline Research Project - Rental Rates on Equipment - Regional Drilling Department

Attached is a list of rates applicable to equipment supplied by the Regional Drilling Department for the above project. All rates quoted are less than those charged by commercial rental service companies for similar equipment. Our charges will commence August 3, 1967, and will continue until the equipment is returned to Arctic Red River.(*)

Your project will be charged labour, fuels, oils, greases, and repairs associated with any of this equipment while used on the project.

These rates were compiled after intensive study of expected operating conditions, availability of similar equipment at Inuvik, commercial rates at Inuvik, and our "break-even" point to meet bare daily expenses. They represent a minimum charge to the project.

V. H. Hunter

ASM/mb
Encl.

(*) Note: In a discussion with Mr. S. Murray, a more definite deal was made, namely, "Our charges will commence Aug. 3, 1967, and continue until the job is finished, plus two days." ... The "two days at" the end of the job will be paid instead of stand-by time while awaiting barges, and barge transportation costs out of Inuvik. Costs will continue for so many days and no more; there will not be an indefinite time of paying charges "until the equipment is returned to Arctic Red River".

EQUIPMENT RENTAL RATES
ARCTIC PIPELINE RESEARCH PROJECT

2 only	10' x 40' Sleepers each	$30.00/day
1 only	Welder, Electric	9.00/day
1 set	Welding Equipment, Acetylene	6.00/day
1 only	Air Compressor and Jack Hammer	22.50/day
1 only	Wood Chipper	7.50/day
4 pcs.	Rig Matting	N/C
1 only	Sleigh	N/C
1 only	Winch Line (Spare)	N/C
300'	Cable, Soft Lay, 3/4"	N/C
1 only	D7 Cat w/Poles and Ripper	50.00/day + 15.00/operating hour
1 only	Track Unit, Nodwell	50.00/day + 15.00/operating hour
1 only	Power Wagon, 4x4 Crew Cab	25.00/day

ITEMS	WEIGHT	SHIPPING CHARGE
TREE RIVER		
1 - D7 Cat w/Dozer,Gin Poles & Front End Ripper	22 Ton	440.00
2 - 10 x 40, 9 Man Sleepers	8 Ton	160.00
1 - Lincoln Arc Welder & Leeds	1 Ton	22.00
1 - Compressor & Jack Hammer	1 Ton	20.00
1 - Sleigh for Welding Machine	1 Ton	20.00
1 - Wood Chipper	1 Ton	20.00
20 - Logs	5 Ton	100.00
ARCTIC RIVER		
1 - Nodwell & Poles	5 Ton	55.00
1 - Dodge Power Wagon Crew Cab	3 Ton	30.00
4 - Pieces Rig Matting 7.50' x 30	14 Ton	154.00
TOTAL SHIPPING CHARGE		1067.00

Line Pipe, Edmonton to Hay River	27 Ton	761.17
1 - Skip Box w/Valves, Flanges, Etc.	4350 Lbs.	183.57

Shipping Charge Hay River to Inuvik Approximately $43.00 Per Ton

July 25, 1967

Re: Arctic Test Installation

File: 9.666E

Mr. E.W. Christian
Imperial Pipe Line Co. Ltd.
11160 Jasper Avenue
Edmonton, Alberta

Attention Mr. J.E. Lyle

Dear Sir:

We have revised the drawing for the test installation as per the copy returned to us by Mr. F. Pasemco with his letter of July 12, 1967 and are attaching copies for your use in the field.

The telephone report of your progress in lining up material, equipment and manpower for the installation work is most favourable and your assistance is greatly appreciated.

Additional copies of this drawing will be sent to you when printed for use by those involved in the installation.

Yours very truly,

K.R. Shipley,

By:______________________
W.J. Keys.

WJK/EG.

cc. Mr. Colin Duncan, Calgary.

Encl.

IMPERIAL OIL LIMITED

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION
E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE, EDMONTON, CANADA

P/L DIVISION
FILE No. 9.666E
JUL 24 1967

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WJK	✓		WJK

DATE ANS'D 14/61.

July 20, 1967

Our File 37.37

Mr. K. R. Shipley,
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

Attention Mr. W. J. Keys

Re Arctic Pipelining Research Project #483
Credit for Land Maintenance

Last week Mr. S. G. Lange, District Landman for Imperial Oil Enterprises, brought to our attention that the Arctic Pipelining project planned for the Inuvik area very probably could qualify as an "allowable expenditure" with the Department of Indian Affairs and Northern Development, Ottawa, from whom I.O.E. could claim a "credit for land maintenance." After discussing this briefly with Mr. Christian and Mr. Keys, it was decided to have Mr. Lange make the required application. Attached for your information and reference is a copy of the application sent to Mr. G. H. Caldwell on July 12, 1967.

The proviso at the end of Mr. Lange's letter should be noted carefully. If the Government gives its approval and the $30,000 mentioned is recognized as an allowable expenditure, then the credit would go to I.O.E. "for normal work obligations on Group 185 permits," as stated, rather than to the accounts being charged with the cost of the pipeline research project. It appears that, of those involved in this project, only I.O.E. has acquired land in the Northwest Territories for exploration and consequently undertaken the required "normal work obligations," and therefore is the only one who can benefit from such a credit. In other words, I.O.E. is applying to have the Arctic Pipelining project recognized as part of the work obligation for which it is responsible in order to maintain its land position in the area covered by the Group 185 permits. On a corporate basis, such a credit would be beneficial.

We are advised further that there may be some tax credits for research work for which Research Project #483 could qualify. It is suggested that the Tax Department be asked to investigate these possibilities if the situation is not already covered in existing tax-research relationships and practices.

Yours very truly,

E. W. CHRISTIAN

John E. Lyle

JEL/McB
Enc.

P/L DIVISION
FILE No. 9.666E
JUL 24 1967

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KRS	✓		
CC	✓		
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DATE ANS'D 1461

July 20, 1967

Our File 37.3

Mr. K. R. Shipley,
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

Attention Mr. W. J. Keys

Re Arctic Pipelining Research Project #483
Credit for Land Maintenance

Last week Mr. S. G. Lange, District Landman for Imperial Oil Enterprises, brought to our attention that the Arctic Pipelining project planned for the Inuvik area very probably could qualify as an "allowable expenditure" with the Department of Indian Affairs and Northern Development, Ottawa, from whom I.O.E. could claim a "credit for land maintenance." After discussing this briefly with Mr. Christian and Mr. Keys, it was decided to have Mr. Lange make the required application. Attached for your information and reference is a copy of the application sent to Mr. G. H. Caldwell on July 12, 1967.

The proviso at the end of Mr. Lange's letter should be noted carefully. If the Government gives its approval and the $30,000 mentioned is recognized as an allowable expenditure, then the credit would go to I.O.E. "for normal work obligations on Group 185 permits," as stated, rather than to the accounts being charged with the cost of the pipeline research project. It appears that, of those involved in this project, only I.O.E. has acquired land in the Northwest Territories for exploration and consequently undertaken the required "normal work obligations," and therefore is the only one who can benefit from such a credit. In other words, I.O.E. is applying to have the Arctic Pipelining project recognized as part of the work obligation for which it is responsible in order to maintain its land position in the area covered by the Group 185 permits. On a corporate basis, such a credit would be beneficial.

We are advised further that there may be some tax credits for research work for which Research Project #483 could qualify. It is suggested that the Tax Department be asked to investigate these possibilities if the situation is not already covered in existing tax-research relationships and practices.

Yours very truly,

E. W. CHRISTIAN

JEL/McB
Enc.

IMPERIAL OIL ENTERPRISES LTD.

3237

F.A.L.M.			J.E.L.
			L
JUL 18 1967			
E.W.C.	J.D.J.	R.M.R.	R.L.S.

July 12, 1967.

NWT - 273

Mr. G. H. Caldwell,
Chief, Resource Management Division,
Resource and Economic Development Group,
Department of Indian Affairs and
Northern Development,
Centennial Tower,
400 Laurier Avenue West,
OTTAWA 4, Ontario.

Dear Sir:

Re: Pipeline Research Project - Inuvik Area

The Pipeline Division of Imperial Oil Limited, with the assistance of Imperial Pipeline and Imperial Oil Enterprises personnel, plan an experimental pipeline project about 2 miles south of Inuvik in proximity to the airport road.

The project will entail the laying of a 2,200-foot pipeline through several different types of terrain; i.e. muskeg, lake, stream etc. Strain gauges and thermistors will be installed at intervals along the line and readings taken regularly for at least a year. The pipeline will not be filled for the first year; next year the project may be continued by filling the line with crude oil, circulating it, and continue taking readings for some time.

Pipe of 6", 10", and 16" diameters will be used. Some of the line will be laid on surface, some partially buried, and some will be buried in the conventional manner. We hope to start laying the pipeline during the first week in August.

The object of this project is to determine the best and most efficient method of laying a pipeline in the permafrost areas and to test material requirements for pipelines of various diameters under arctic conditions.

The National Research Council personnel at Inuvik, under the supervision of Mr. Hill, have agreed to take necessary readings and make periodic visual inspections of the line. All basic data

/2

COPY

IMPERIAL OIL ENTERPRISES LTD.

in connection with the project will accordingly be available to the National Research Council; we assume that it will not be necessary to divulge our own interpretation of this data.

We estimate that the cost of this project will be approximately $30,000. We hereby apply to have this expenditure approved as an "allowable expenditure" according to Section 48, Paragraph 2 of the Act with the proviso that the credit can be used for normal work obligations on Group 185 permits.

Yours very truly,

P. STAUFT
DISTRICT EXPLORATION SUPERVISOR

Copy (Original Signed) S. G. Lange
S. G. Lange
District Landman

SGL:mht

cc: J. Lyle/Imperial Pipeline✓
Calgary Land

1240/2 A

COPY

Standard Oil Company

INCORPORATED IN New Jersey

30 ROCKEFELLER PLAZA, NEW YORK, N.Y. 10020

Transportation Coordination Department

L. B. MORROW
Manager, Pipe Line Research

July 17, 1967

Mr. K. R. Shipley
Imperial Oil Limited
111 St. Clair Avenue West
Toronto, Ontario, Canada

Dear Mr. Shipley:

1967 Budget -
Pipe Line Research

We thank you for your letter of July 7 which provided budget information on projects assigned to Imperial under the Pipe Line Research Program. A letter is planned in the near future to the Advisory Committee informing them of the mid-year budget status of the program and requesting their approval for the overexpenditure on certain of the projects.

C.V.H.

The events in 1966 which precluded charging nearly $20,000 against project #483 are unfortunate. It is hoped that some revision in Imperial's accounting system can be arranged so that future problems of this nature can be averted. Invoicing on a monthly basis has been found to be a solution among other participants. At least then one misplaced invoice would not prove so disconcerting. ?

We would appreciate knowing the nature of the overexpenditures against project #403, Multiphase Flow Investigations. According to our latest information a Final Report was scheduled for the end of the First Quarter of this year and $7,000 was estimated as the cost of getting this done. We have had several inquiries concerning the Final Report so would also like to have the revised date for its completion.

The information on project #403 will be required for inclusion in the letter to the Advisory Committee so your immediate assistance in obtaining an answer would be appreciated.

Yours very truly,

L. B. Morrow.

L. B. Morrow

LBM:jmm

CR: 9.301

P/L DIVISION
FILE No. 9.666E
JUL 19 1967

	NOTE	ACT	INITIAL
KRS	✓		
CC (R)	✓		-
OMK			
RAP			
LDA			
BMS			
CJB			
RDC			
CVH	✓		
WJK	✓		

DATE ANS'D 14/6.

wrote to L. Keet on July 21/67.

PURCHASING DEPARTMENT

MEMORANDUM

July 13, 1967

Order: 02W-6343257
Req'n: 483-1
Canadian Phoenix Steel & Pipe Ltd.

Mr. W. E. Barratt
B U I L D I N G

Attention: Mr. K.R. Shipley (J. Keys)

For your information and records please find attached copy of our Western Division order at Canadian Phoenix Steel and Pipe Ltd. covering material for the Arctic Pipe Line Research Project.

O. K. SMITH

Per J L Forrest
J. L. Forrest

JLF:nb
7/23
Attach.

?-

P/L DIVISION
FILE No. 9.666E
JUL 14 1967

	NOTE	ACT	INITIAL
KRS			
CC			
OMK			
RAP			
LDA			
DMB			
CJB			
RDC			
CVH			
WJK	✓		WJK

DATE ANS'D 1384

to Hay River.

2S-404/A 2/67

IMPERIAL OIL LIMITED

PURCHASING DEPARTMENT
WESTERN DIVISION
11160 JASPER AVENUE, EDMONTON, CANADA

PURCHASE ORDER

ORDER No. 02W-63--43257
REQ'N. No. 483-1
LOCAL No.

PLEASE ACKNOWLEDGE ACCEPTANCE OF THIS ORDER AND ADVISE EARLIEST POSSIBLE DELIVERY DATE.

July 7, 1967

Canadian Phoenix Steel & Pipe Ltd.
6th Floor, 620 Bentall Building
CALGARY, Alberta

SHIP TO:

Imperial Pipe Line Company
Inuvik, N. W. T.

YOU ARE REQUESTED TO FURNISH THE UNDERNOTED GOODS AND/OR SERVICES TO:
AND SHIP TO ARRIVE Mid-August
VIA Our pick up for delivery to Northern Transportation Co. Ltd. at Hay River, N.W.T.

IMPORTANT

1. THIS ORDER IS SUBJECT TO THE TERMS AND CONDITIONS ON BOTH SIDES HEREOF.
2. IF UNABLE TO COMPLETE SHIPMENT OR SERVICES BY DATE SPECIFIED, ADVISE IMMEDIATELY GIVING FULL DETAILS.

QUANTITY	MATERIAL CODE	MATERIAL SPECIFICATION	PRICE
		CONFIRMING PHONE ORDER June 30	
1,000 ft.		PIPE, steel, line, electric resistance weld, black, bare, API Std. 5L, grade B, bevelled for welding, approx. 40 ft. lengths, size 6.625" x .125" wall @	$ 74.76/ C Ft.
850 ft.		DITTO - except 10.75" O.D. x .188" wall @	$ 182.74/ C Ft.
650 ft.		DITTO, except 16.00" OD x .188" wall @	$ 274.82/ C Ft.
440 ft.		DITTO, except 3.5" OD x .125" wall @	$ 38.84/ C Ft.

NOTE: 1. Due to distance of shipping and handling problems the lengths should be held at approx. 40 ft. if possible.

- Price per your quotation C-3584, June 12

IF ADDITIONAL INFORMATION IS REQUIRED CONTACT D. D. FOSTER

MAIL 4 COPIES OF CUSTOMS INVOICES TO:

MAIL 3 COPIES OF PAYMENT INVOICES TO: IMPERIAL OIL LIMITED
WESTERN PURCHASING DIVISION
11160 JASPER AVENUE, EDMONTON, CANADA

F.O.B. Edmonton
FEDERAL SALES TAX Applicable
TERMS NET
PROVINCIAL TAX

IMPERIAL OIL LIMITED
PER

EXTRA COPY

REQUIRED ON SITE BY
EST. COST $ 5600.00 inc.trans.
S.T.A. No. Pipe Line Research Program 430-0005.
CHARGE:

NB- 1. 960' of item 4 covering 3-1/2" pipe being supplied from Prod. D surplus, Edmonton.
2. Total order being hauled by IOL Regional Drill. Dept. at an agreed price of $762.18/lot Edm. to Hay River.

2S-404/A 2/67

TERMS AND CONDITIONS

1. This order, together with the acceptance by the Seller and all documents, drawings and specifications referred herein, shall constitute the contract between the Seller and the Purchaser and no qualification of the Seller's acceptance or oral statement of any person whomsoever shall be binding upon the parties unless stipulated and agreed to by them in writing.

2. In accepting this order the Seller undertakes and agrees to provide all the materials and/or to perform all the services (herein called "the work") shown or described in the contract documents and in strict compliance therewith; and the Seller further undertakes and agrees that all persons engaged upon the work or entering upon the premises of the Purchaser for the purpose of performing the contract shall be considered servants of the Seller and not of the Purchaser.

3. The Purchaser shall have the right to change the work in any way; provided that such change and any changes in the terms of the contract required to be made in consequence thereof shall first be specified in writing.

4. If in the opinion of either party the work is delayed by the other for causes other than those beyond its control or is jeopardized by reason of faulty workmanship or insolvency on the part of either party the party not so in default, in addition to any other remedy, may on three days written notice to the other terminate the contract and recover any loss sustained by reason of such termination.

5. The Seller in the performance or purported performance of this contract, shall be responsible for and shall save harmless and indemnify the Purchaser from and against all loss, costs, damages, suits, claims and demands of every nature whatsoever relating to any infringement of copyright, trade mark or letters patent.

6. Save where the work is the bare provision of materials to the Purchaser, the Seller shall:

(a) Be liable for and shall indemnify and save harmless the Purchaser of and from all manner of actions, causes of action, proceedings, claims, demands, loss, costs, damages and expenses whatsoever which may be brought or made against the Purchaser, or which it may sustain, pay or incur as a result of or in connection with the performance, purported performance or non-performance of this contract or of the work hereunder by the Seller or his sub-contractors and whether the same result from or in connection with the use by the Seller or his sub-contractors of any machinery, tools, or equipment belonging to the Purchaser, or from or in connection with the negligence or wilful acts or omissions of the Purchaser, its servants, agents, employees or its other contractors while acting under the direction or control of the Seller or his sub-contractors, but excluding any such actions, causes of action, proceedings, claims, demands, loss, costs, damages and expenses to the extent that they are sustained, paid or incurred by reason of or are otherwise attributable to the negligence or wilful acts or omissions of the Purchaser, its servants, agents, employees or its other contractors while not acting under the direction or control of the Seller or his sub-contractor; provided however, that the liability of the Seller hereunder in respect of loss or damage to property, including loss of use thereof, belonging to or in the custody of the Purchaser (other than the work, materials and equipment covered by this contract) shall not exceed $1,000,000 any one accident;

(b) At all times pay or cause to be paid any assessment or contribution required to be paid pursuant to the Workmen's Compensation Act of each Province in which the work is situate and upon failure to do so the Purchaser, in addition to any other rights reserved to it under this contract, may retain the amount of such assessment or contribution from any payment then due or to become due to the Seller under this contract. Before commencement of the work under this contract the Seller shall deliver to the Purchaser, at the office from which the work is being supervised, certificates from the Workmen's Compensation Board that all assessments and contributions payable to the Workmen's Compensation Board have been paid by the Seller and his sub-contractors and before the final payment is made by the Purchaser the Seller shall deliver similar certificates to the Purchaser with his application for final payment;

(c) Carry automobile and non-owned automobile insurance in such amounts as the Purchaser may require, and proof of such insurance shall be filed with the Purchaser if requested.

7. The contract shall not be assigned or sub-let by either party save with the prior written consent of the other.

INSTRUCTIONS

INVOICING

1. ALL SUPPLIERS must render payment invoices in triplicate, unless otherwise instructed, to the address given on this order.

2. FOREIGN SUPPLIERS must also forward certified customs invoices in quadruplicate to address given on this order immediately merchandise is ready for shipment. Do NOT deduct cash discounts on customs invoices.

3. When payment invoices subject to cash discounts are not mailed on date of shipment, discount period will be calculated from date invoices are received.

4. Code numbers shown on this order must appear on payment invoices and packing lists.

5. This order and requisition numbers must appear on all invoices, bills of lading, express receipts and correspondence.

MARKING

1. Order and requisition numbers must appear on all packages. When nature of materials does not permit boxing or marking of order and requisition numbers directly on materials, e.g., (steel bars, rods, small pipe, castings, valves, fittings, etc.), use a metal tag affixed by wire showing this information.

SHIPPING

1. Ship via cheapest method, unless specifically instructed otherwise. Consider POOL CAR shipments.

2. Routing for carload shipments, if not shown hereon, must be obtained from the ordering office. Advise shipping point and originating railroad.

3. PACKING LIST must accompany each shipment.

4. SHIPPING NOTICE must be mailed to consignee immediately merchandise accepted for forwarding by transportation company.

5. CANADIAN SUPPLIERS SHOULD PREPAY TRANSPORTATION CHARGES. If charges are for our account, include on payment invoice as a separate item, and attach SIGNED ORIGINAL RAILROAD BILL OF LADING describing articles in accordance with freight classification, express or other receipts.

6. FOREIGN SUPPLIERS must NOT prepay transportation charges.

7. SIGNED ORIGINAL OCEAN BILL OF LADING must accompany customs invoices.

8. SIGNED COPY OF ORIGINAL OCEAN BILL OF LADING MUST accompany payment invoices.

THE IMPERIAL PIPE LINE COMPANY, LIMITED

E. W. CHRISTIAN,
PRESIDENT & GENERAL MANAGER

C. R. PERRY,
SECRETARY & TREASURER

11160 JASPER AVENUE
EDMONTON, ALBERTA
CANADA

P/L DIVISION
FILE No. 9.666E
JUL 14 1967

	NOTE	ACT	INITIAL
KRS			
CC			
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		WJK

DATE ANS'D 1380.

July 12, 1967

Our File: 60.45

Mr. K. R. Shipley, (WJK)
Pipe Line Division,
Imperial Oil Limited,
Box 4029, Terminal 'A',
TORONTO 1, Ontario.

Revised Dwgs
sent
JWK

Re: Arctic Test Installation
Your File: 9.666E

Dear Sir:

We have attached one copy of the revised site installation drawings showing the fitting changes that we discussed. You will also note that at location "A", revision has been made back to the original drawing. The reason for this is that the material has already been purchased and shipped. This should present no difficulty as it will give us provision for a "return line" tie-in if one is required in the future.

The pipe and the fittings were shipped and left Edmonton for Hay River on July 7.

We would appreciate new, revised drawings as soon as they are available.

Yours very truly,

E. W. Christian,

by Fred Pasemco
F. Pasemco

FP:ed
Enc.

July 12, 1967

<u>Re: Pipe Line Research Project</u>

File: 9.666E

Mr. L.B. Morrow
Standard Oil Company (N.J.)
Transportation Co-ordination Dept.
30 Rockefeller Plaza
New York City, N.Y. 10020

Dear Sir:

We have attached a copy of a request from Imperial Pipe Line Co. Ltd. for copies of final reports on various past Research Projects. If you can comply with the request, please send copies direct ly to Mr. F. Pasemco of Mr. E.W. Christian's office in Edmonton with a copy of the covering letter to this office.

Yours very truly,

K.R. Shipley,

By:________________________
W. John Keys.

WJK/EG.

July 7, 1967

Re: 1966 Expenditures and 1967 Budget, Project # 483

File: 9.666E c.r. 9.301

Mr. L.B. Morrow
Standard Oil Company (N.J.)
Transportation Co-ordination Dept.
30 Rockefeller Plaza
New York City, N.Y. 10020

Dear Sir:

Further to our telephone conversations during the past two weeks regarding the carry-over from the 1966 budget on project #483, the following will serve as a resumé of these figures as we now understand them.

On December 30, 1966 Imperial Oil Limited Comptroller's Department, Don Mills forwarded invoice No. 4476C to Esso International in the amount of $15,734.02 ($14,517.78 U.S.). This represented the charges against project #483 up to November 30, 1966.

During the balance of 1966 charges of $3,897.75 (Can.) were collected against this project. At the end of May, 1967 Comptroller's invoiced Esso International in the amount of $4,882.72 (Can.) which was made up of the above 1966 balance of $3,897.75 (Can.) and 1967 expenditures by the Pipe Line Division of $984.97 (Can.).

Charges against this project from the Producing Department in Calgary were $2,851.46 up to the end of May. These latter charges were forwarded to our Don Mills Comptroller's early in June and therefore do not show up in the above invoice for $4,882.72. This would make a total to the end of May, 1967 against project #483 of $3,836.43.

Our estimate for the test installation work in the Arctic is $45,000 made up as follows:

(1)	Instruments, strain gauges and test equipment	$14,500
(2)	Pipe	4,500
(3)	Fittings, valves, etc.	3,700
(4)	Installation	22,300

Pipe Line Co. Ltd.

Mr. L.B. Morrow/New York July 7, 1967

In addition to the above amount and expenditures by this office and Calgary to date, it is further estimated that at least $10,000 will be required to carry on the balance of the year's work on this project.

We are advised that charges against project #403, Multiphase Flow Investigations, to the end of May, 1967 are $9,938.15 and it is estimated that total 1967 charges will amount to about $14,000. We have not enquired as to the nature of these charges but it is understood that work on the project will not be completed until at least July 31. Further, this represents an overrun of the budgeted amount rather than leaving some surplus funds.

After you have had an opportunity to review these figures, we will be pleased to discuss them with you by telephone to determine whatever action is necessary.

Yours very truly,

K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG

July 6, 1967

Re: Arctic Test Installation

File: 9.666E

Mr. E.W. Christian
Imperial Pipe Line Co. Ltd.
11160 Jasper Avenue
Edmonton, Alberta

Attention Mr. F. Pasemco

Dear Sir:

We have attached two copies of our revised site installation drawing showing the proposed anchor changes and road crossing change. This was brought to our attention since heat would be transmitted to the anchor pipe thereby causing thawing and loosening. It is felt that this type of anchor should be adequate, however, you should feel free to change to suit field construction conditions and materials.

Please mark up the fitting changes we discussed and return one copy of this drawing so that we can bring our original up to date. Your progress in obtaining material and arranging shipping sounds very good and we wish to thank you for your effort in this regard.

By copy of this letter and attached drawing to others in this project, further suggestions and comments are welcomed.

Yours very truly,

K.R. Shipley,

By:____________________________
W.J. Keys.

WJK/EG
cc. Mr. Colin Duncan, Production Research Dept. Calgary
Mr. Scovil Murray, Regional Drilling Dept. Edmonton.

HUMBLE PIPE LINE COMPANY
P. O. Box 2220
Houston, Texas 77001

July 5, 1967

TECHNICAL SERVICES DEPARTMENT
GEORGE G. HUGHES, JR.
MANAGER
A.V. CARDIN
ENGINEERING COORDINATOR
J. E. BARBEE
COMMUNICATIONS COORDINATOR
ROBERT L. BULLOCK
RESEARCH COORDINATOR

Arctic Pipe Stress Test, PLR #482

P/L DIVISION
FILE No. 9.666E
JUL 7 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		cl
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		

DATE ANS'D 13-29.

Mr. K. R. Shipley, Manager
Transportation and Supply Department
Imperial Oil Limited
111 St. Clair Avenue West
Toronto, Canada

Attention: Mr. W. J. Keys

Dear Mr. Shipley:

We have reviewed the proposed test site location-installation plans and agree that you have selected a very versatile location in that it includes about as many variables as the length of the test section will accommodate.

We do not recommend any coating tests on the proposed pipe stress test for the following reasons:

- Cold weather conditions for laying any pipelines in the Arctic will, at this time, dictate the use of plastic coating materials such as tape or extruded coating.

- The stresses experienced by the pipeline are of primary importance. We know of no coating as strong as steel and, therefore, we could expect distortion and rupture of the coating if the pipe experiences such. ?

- The coating of the test pipe would be limited to areas not subject to strain gage applications.

Imperial is complimented on getting the job under way. We wish Alex Hemstock and his group every success on the installation and test results.

We do not anticipate any assignments for our Arctic project this year. Since you seem to be in a budget bind, we suggest that you use the $13,500.00 remaining in our assigned project and use the assigned PLR #482 for the expenditure of this amount of money. We discussed this with Mr. Morrow on his recent visit and it was agreed that if Humble Pipe Line Company gave Imperial permission to use the

assigned number, the use of the funds would be within the Pipe Line Research Agreement. After all, the Arctic project is a combined project between Imperial and Humble Pipe Line.

Yours very truly,

Robt L. Bullock

Robert L. Bullock

RLB:mac

cc: Messrs. L. B. Morrow
R. A. Hemstock

Producing.

67 JUN 30 PM 4 08

IMPERIAL OIL LIMITED
TELETYPE MESSAGE

Larry Keats. -

- Diniskid July 31/

1

2633

E-13 EDM JUNE 30/67 12:45

$14,000.00

K R SHIPLEY
ATTN C V HOLMES
TORONTO

REURTEL I-16 JUNE 29/67. CHARGES TO PROJECT 403 TO END OF MAY 1967 $9,938.15
CANADIAN ESTIMATE FOR 1967 12,000.00

R A WILSON SEC 5.1 - H G SOMMERSTAD

~~16 29 67 403 1967 9,938.15 1967 12,000.00~~

File 9.666.E

12:55 GG

9.666E.

REQUISITION

MAIL TO:

PURCHASING DEPARTMENT — TORONTO ☐

WESTERN PURCHASING DIVISION — EDMONTON ☐

ATLANTIC PURCHASING DIVISION — HALIFAX ☐

PLEASE PURCHASE THE FOLLOWING
(PURCH. DEPT. USE ONLY)

ORDER FROM

SHIP VIA:

DATE June 30, 1967

FROM T. & S. Pipe Line Division

PURCH. DEPT. EXTRA COPIES

PURCHASING DEPT. ORDER NUMBER REV. SH.

DIVISIONAL PURCH. OFFICE REQ'N No. REV. SH.

ORIGINATORS REQ'N No. 483-1 REV. SH.

ORIGINATORS LOCAL No. REV. SH.
(FOR REQUISITIONING DEPARTMENT USE)

SHIP TO:

Imperial Oil Limited
Inuvik, N.W.T.

SHIP VIA CHEAPEST METHOD ☐ RAIL EXP. ☐ AIR EXP. ☐ AIR FRT. ☐

ORDER NUMBER (PURCH. DEPT. USE ONLY)	VENDORS CODE No.	√	QUANTITY	I.O.L. STANDARDS CODE No.	MATERIAL SPECIFICATIONS (FOR REQUISITIONING DEPARTMENT USE)
					Reference quotations attached to your letter of June 16, 1967 regarding Arctic Pipe Line Research, the following is a <u>confirming</u> order of pipe ordered from Alberta Phoenix, Edmonton.
					<u>Item 1.</u>
			1,000 ft.	Class 63	Pipe, steel, line, electric resistance weld, black, bare, API Std. 5-L, Grade B, bevelled for welding, approximately 40 ft. lengths. Size: 6.625" x .125" wall.
					<u>Item 2.</u>
			850 ft.	Class 63	Ditto Item 1 except 10.75" O.D. x .188" wall
					<u>Item 3.</u>
			650 ft.	Class 63	Ditto Item 1 except 16.00" O.D. x .188" wall.
					<u>Item 4.</u>
			1,400 ft.	Class 63	Ditto Item 1 except 3.5" O.D. x .125" wall.

(PURCH. DEPT. USE ONLY)

F.O.B.

CONFIRMING:

REFER TO YOUR QUOTATION No. DATED

FUNDS: TERMS: FEDERAL SALES TAX:

(FOR REQUISITIONING DEPARTMENT USE)

REQUIRED ON SITE BY: Mid-August

FEDERAL SALES TAX: APPLICABLE ☐ EXEMPT ☐

S.T.A. No.:

REMARKS:

ESTIMATED COST: Approx. $5,600.00 incl. transportation

CHARGE: Arctic Pipe Line Project #483,
Pipe Line Research Program 450-0006

APPROVED: H. J. Keys SIGNED: H. J. Keys

2 R-193/4

T. & S. Pipe Line Division **Requisition 483-1**

NOTES:

1. Due to distance of shipping and handling problems the lengths should be held at approximately 40 ft. if possible.
2. Best method of shipping to be arranged by Mr. J.E. Lyle and Mr. D.D. Foster in Edmonton.

IMPERIAL OIL ENTERPRISES LTD

11650 - 142ND STREET, EDMONTON, ALBERTA

Esso

REGIONAL DRILLING DEPARTMENT

V. H. HUNTER, MANAGER

June 29, 1967.

P/L DIVISION
FILE No. 9.666E
JUL 4 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		CC
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		WJK

DATE ANS'D. 13/1A

Memorandum Augmenting John Keys' Letter June 26/67

TO: Messrs. Colin Duncan, Calgary
Alex Hemstock, Calgary
W. John Keys, Toronto
John E. Lyle, Edmonton

Dear Sirs:

RE: <u>Pipeline Research Project - Inuvik Area.</u>

This letter summarizes various conversations and meetings which have taken place recently relating to the above topic:

1. The Regional Drilling Department has appointed Mr. A. J. (Al) Bennett as its coordinator to work with members of this project in any way that will optimize your efforts. Al will be available throughout the summer months and well into September. He is a very capable toolpusher and has operated our National #3 rig at its Arctic locations since the program's inception. He can be reached through our Regional Drilling Department in Edmonton, phone 454-8671.

2. During a meeting with John Lyle it was decided that the following equipment, personnel, and materials available from the Regional Drilling Department at McPherson, Arctic Red, or Tree River would be required:

   A. Rig matting - 4 pieces
   B. D-7 and D-8
   C. Nodwell
   D. Kenworth truck and hi-boy
   E. Jackhammer and compressor
   F. Lincoln arc welder
   G. Drivers for above mentioned units

   The above, of course, is subject to change as your plans develop.

3. We suggested hiring a qualified pipeline welder to do the welding and obtain pipeline clamps from his Company. Weld-O-Matic in Edmonton was suggested.

4. We suggest looking at the economy and facility of moving two bunkhouses and one wash house from Tree River to Inuvik. First, however, Inuvik should be checked out to see what accommodation is available. It could be tough. A power wagon, pickup, or some other means of transportation should be provided for moving personnel to and from the job and chasing supplies. Check with our Northern Exploration Group to see if their unit would be available - also have they spare accommodation.

5. Spare winch lines should be taken in to minimize down time from this potential source of lost time.

6. Al Bennett would be useful in working with John Lyle or others in finding casual labor needed for clearing brush, digging ditches, etc. A trip to Inuvik prior to starting operations to determine availability of a manpower source may be advisable.

7. The Regional Drilling Department could provide several roughnecks who are skilled in many ways to supervise casual labor and do other tasks if such men might be useful.

8. John Keys advises that John Lyle and Bob Chalmers will be on site directing activities of the project. Al Bennett would be glad to work with these men in any way they so desire to maximize effort and minimize cost.

9. This Research Project would be required to accept the following charges from the Regional Drilling Department:

   (1) Cost of moving any of our equipment or materials from Tree River, Arctic Red River or Ft. McPherson to Inuvik and back to these locations.

   (2) Labor at actual cost covering our personnel supplied to the job. Room and board of these personnel when called out on the job and until finished. Transportation to and from Inuvik from origin where these men are available. (If I.O.G. - no charge.)

   (3) Nominal rental on any equipment, materials, housing, or suchlike supplied by Drilling Department. We guarantee that our rental rates are lower than that available through commercial sources.

10. We have suggested that the project start as early in August as possible. Unforeseen difficulties frequently arise in remote operations which extends projected time periods. We wish to bring some of the equipment useful to this project out to Edmonton when finished. This requires catching the last barge up river to the town of Hay River.

11. We sympathize with Colin Duncan's problems concerning obtaining various instrumentation. We hope he will be successful in "oiling the squeeking wheel" frequently to obtain the earliest delivery dates.

12. Doug Foster advises he is ordering all the pipe out of Edmonton. Our Transportation Department is currently studying economics of using our own trucks to move this pipe to Hay River compared to a commercial trucking company

13. Summary -- here are some points that should be investigated in the near future:

    A. Accommodation facilities available in Inuvik for personnel -- decision whether or not to bring two bunkhouses and two wash houses from Tree River.

    B. Size and availability of casual labor force at Inuvik.

    C. Reserving barges in advance so they will be available when needed.

    D. Scheduling manpower to load equipment from up river (Tree River, etc.) to Inuvik. Also arrange for Transportation Department personnel -- drive cats, Nodwell and Kenworth, so holidays won't interfere.

    E. Arrange for a qualified pipeline welder in advance -- pipeline clamps.

14. The Regional Drilling Department is most happy to work with you on this job supplying personnel, materials and equipment at the lowest possible costs.

A. S. Murray
for V. H. Hunter

ASM/il

June 27, 1967

<u>Re: Arctic Test Installation</u>

File: 9.666E

Mr. R.L. Bullock
Planning and Development Dept.
Humble Pipe Line Company
P.O. Box 2200
Houston, Texas, 77001.

Dear Sir:

We have attached a copy of the proposed test site lay-out for stress determination and also a copy of the drawing showing proposed strain gauge installations. It is presently planned to install this section of pipe around the middle of August if material deliveries can be maintained.

It is planned to use bare pipe throughout since coating the pipe would complicate the installation of test equipment. As discussed briefly with Mr. Morrow last week, sections of coated pipe could be installed separately in this same area if you feel that this would provide any worthwhile information of the coating phase of this project. Please advise if you wish any yard coated or field coated pipe to be installed.

Yours very truly,

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.
cc. Mr. Lionel Morrow, New York,
(with encls.)

Encls.

June 27, 1967

Re: Test Installation - Arctic Pipe Line Research

File: 9.666E

Mr. E.W. Christian
Imperial Pipe Line Co. Ltd.
11160 Jasper Avenue
Edmonton, Alberta.

Attention Mr. J.E. Lyle

Dear Sir:

We have attached hereto, a copy of the fittings and valves required for this installation. As discussed with you by telephone we feel advantageous for you to proceed with obtaining these items locally in Edmonton since all material will be shipped from that point. Also, it is possible that you may be able to locate some surplus material that would serve satisfactorily for this purpose.

The 6", .125" wall pipe will float in the lake section of the installation. Pipe would have to be at least .219" wall or thicker for natural negative buoyancy. For this reason the pipe will have to be filled with fluid to ensure settling to the lake bottom. This could be achieved with diesel oil and you may wish to consider the installation of an extra set of flanges each side of the lake to permit blanking off because of welding on the balance of the line. We will review this matter with you by telephone after you have had an opportunity to give it some thought.

Yours very truly,

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.
Encl.

ARCTIC TEST INSTALLATION

VALVES AND FITTINGS

A. **Fittings**	(1) Flanges	3 - 6" - ASA 300#	r.f.
		4 - 6" - ASA 150#	"
		2 -10" - "	"
		8 - 3½" - "	"
	(2) Reducers	1 - 16" x 6" eccentric	
		1 - 10" x 3½" "	
		1 - 6" x 3½" "	
		2 - 6" x 3½" concentric	
	(3) Caps	1 - 10"	
		2 - 6"	
	(4) Tees	2 - 3½" x 3½" x 3½"	
		2 - 6" x 6" x 6"	
		2 - 10" x 10" x 6"	
B. **Valves**		1 - 10" - ASA 150#	
		3 - 6" - "	
		5 - 3½" - "	

NOTE: 1. In addition to the above items, gaskets, bolts, nuts, etc. will be required.

2. Valves can be gate or plug. Any reasonably suitable type should be adequate and if there is surplus stock available this should be used.

3. The exact pipe size of the 3½" coming from Phoenix mill should be checked to insure valve and fitting sizes correspond.

June 27, 1967

W.J. Keys/EG.

June 26, 1967

Re: Test Site Selection - Inuvik Area - Notes

File: 9.666E

Messrs. Colin Duncan,
Calgary,

Alex Hemstock, (2)
Calgary

John E. Lyle (2)
Edmonton,

Scovil Murray,
Edmonton.

Dear Sirs:

Attached herewith is a copy of the notes made regarding the visit to the test site installation in the Inuvik area.

Your comments or suggestions are welcome.

Yours very truly,

K.R. Shipley,

By: ____________________

W. John Keys.

WJK/EG.

Encl.

ARCTIC PIPE LINE RESEARCH

TEST SITE SELECTION - INUVIK AREA

A trip was made to the Inuvik area on June 12-13, 1967 to finalize plans for the test pipe installation planned for analysis of pipe line stresses and construction techniques. The following persons made the trip on the Company F-27 aircraft:

Alex Hemstock,	Production Research, Calgary
Dave Bossler	" " "
Colin Duncan	" " "
Gerry Rempel,	Producing Dept. Co-ordinator, Arctic Exploration, Edmonton
Gord Tunnock	" " Surveying, Edmonton
Jack Betteridge	" " " "
Fred MacPherson	" " " "
Scovil Murray,	Drilling Dept., Edmonton
John Lyle,	Imperial Pipe, Edmonton
John Keys	Pipe Line Division, Toronto

The following is an outline of the work done and plans made for the test installation.

Site: The site originally selected in the vicinity of Gaynor's Lake is satisfactory. This was covered on foot and consists of a route starting on high ground, traversing a corner of the lake to moderately high ground, changing direction for 400 to 500 feet then crossing the airport road, changing direction, through a creek and terminating on high ground.

The survey was completed and will be drawn up by the Edmonton office and made available to Mr. J.E. Lyle who will forward copies.

Options or alternatives on the installation that can be considered are as follows.

(1) Terminate the 6" (far side of the lake) on much higher ground. This will involve nearly 1,000 feet of additional pipe.

(2) Terminate the 10" on higher ground also.

(3) If the road is not crossed with the 10", run parallel to the road, crossing the creek and terminating on high ground.

Installation Work: Reviewing the methods and equipment required and available for the installation the following general plans were made in a discussion with J. Lyle, A. Hemstock and S. Murray.

(a) Producing Drilling Department (S. Murray) will lend all assistance possible re. manpower and equipment for installing the pipe.

(b) A good pipe line welding machine having a 110 V.A.C. outlet is required. Producing will likely have this available or one can be taken in by Company (Caribou) aircraft.

(c) Producing have agreed that, if possible, they will move in a Nodwell unit complete with winch and gin pole, also a large D-8 cat with blade, winch

and ripper. These will probably be available from their site at Tree River. Also, they would want to have the work completed in time to assure they can get the equipment out on the last barges going up the Mackenzie in September.

(d) There are a number of Cats available in the Inuvik area from various sources, such as Government agencies, contractors, Mr. Campbell who operates the Imperial garage, etc.

(e) There is one backhoe on rubber tires (truck mobile unit) of approximately 1/4 to 1/3 cu. yd. bucket size available at approximately $10.00/hr. not including operator from the Dept. of Northern Affairs. A preliminary contact has been made to this department through Dick Hill of the Laboratory. They could not assure full time availability in the August period but felt sure it could be made available to suit our needs a day or two at a time.

(f) Other small equipment, such as trucks, sleds, etc. is generally available for hire from local sources.

(g) Labour is available locally up to the dozen men we felt we would need. By contacting Dick Hill initially, arrangements can be made through the Placement Officer at the Dept. of Northern Affairs. As covered below, it would be desirable to get this labour through a local Contractor rather than direct hiring.

(h) Producing expect that they will have an Expediter located in the Inuvik area at that time who will be available to assist with arranging contacts, transportation, etc.

(i) Miscellaneous equipment required for construction, such as line-up clamps, cutting and bevelling torches, slings, chains, etc. will have to be taken in also.

(j) Dick Hill advised that there was a diesel powered air drill available (at present) in the area which was used to drill pile holes. This would be of value in drilling holes for anchors at the end of the line.

(k) Depending on the technique of construction it may be desirable to take in a supply of heavy plastic bags to use as sand bags for pipe supports, etc.

Special Notes re. Construction

1. It is desirable from a cost stand-point to plan on not using a regular "full-fledged" pipe line contractor. It is believed that Producing (Scovil Murray) can provide the equipment and manpower required for the installation.

2. When using local labour it would be better to get it through a local contractor as this will eliminate the problems of time accounting, wage rates, pension deductions, Workmen's Compensation Board coverage, etc.

3. Bending equipment will not be available so it will be necessary to use Cats and existing equipment for cold bends or bend by heating pipe with torches.

4. The 6" line will tend to float in the lake section. This is to be investigated to decide on what construction technique is to be used, that is, heavy wall pipe, weighting or filling with liquid.

5. Tree clearing should be done manually to conserve the small trees to use as a"mat" at the lake edge to enable ditching some distance into the lake.

6. The road crossing would have to be done on an open cut basis using a detour or or one half of the road at a time. Permission would be arranged from the Government through Dick Hill.

7. Even if the recirculating line is not installed now, provision for crossing the road (sleeve of 6" or 10") should be made during construction.

Test Instruments and Equipment

This will be looked after by Colin Duncan who will arrange purchase of all strain gauges, test instruments, thermistors, cathodic protection test equipment etc. Also prefabrication of all junction boxes, test connectors, etc. will be carried out before field installation as far as possible.

Samples of the pipe to be used are required by Mr. Duncan to enable the strain gauge suppliers to establish the co-efficient of expansion of the pipe.

Some coated sections or separate pieces of coated pipe should be installed to ascertain the suitability of pipe coatings in frozen ice environment and in lake perhaps.

Plans for Construction

1. On the basis of the site survey, little change in plans for the pipe sizes, cover, etc. is anticipated.

2. Producing, Drilling Dept. (Scovil Murray) felt they could provide a crew to install this pipe including a good welder, provide the equipment referred to above (D-8,Nodwell, arc welding machine), haul pipe to Hay River from Edmonton or Regina and most other manpower or equipment needs.

3. J.E. Lyle will act as field engineer and will provide a field supervisor to direct construction techniques.

June 21, 1967

WJK/EG.

June 23, 1967

<u>Re: Arctic Project Test Site #483</u>

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
Production Research Dept.
339 50th Avenue S.E.
Calgary, Alberta

<u>Attention Mr. Colin Duncan</u>

Dear Sir:

We have attached hereto, a revised copy of the Arctic project test site installation. This has been modified in accord with the onsite investigation and the actual survey supplied by the surveying group in Edmonton.

In general, this follows the same lay-out as made up earlier and your proposed test stations should fit in with this plan.

Pipe has been ordered from the Phoenix mill in Edmonton and, as discussed, you can arrange to get pipe samples through Mr. J.E. Lyle of Imperial Pipe.

The question of the budget addition has been discussed with New York and they have advised that due to urgency in obtaining materials and equipment we should proceed as planned, even though the solution for last year's budget carry-over has not been reached.

Yours very truly,

E.R. Shipley,

By:____________________
W. John Keys.

WJK/EG.

cc. Mr. J.E. Lyle.

Dick Hill
the location
test pipeline
of the

H.

P/L DIVISION
FILE No. 9.666E
JUN 22 1967

	NOTE	ACT	INITIAL
KRS			
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DATE ANS'D 1233.

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Canada

our file/notre dossier
your file/votre dossier
date

...ing a pipeline research ... evaluate the construction techniques and ... n arctic pipeline.

..., they propose to lay around 2000 feet of pipe at a spot along the Inuvik airport road 2 miles southeast of Inuvik just past the CBC radio tower. The line would start at a highbank, cross a creek, go under the airport road, cut a corner of Gaynor's Lake, and extend into the high bank North of Gaynor's Lake.

This project will be operated in association with the Inuvik Research Laboratory for an approximate three year period. Imperial Oil will be responsible for laying the line with minimal disruption to traffic on the airport road and for essential cleanup when the project is completed.

While the project is underway, we would request minimal disturbance in the test area.

If you have any questions or suggestions on the project, please let me know.

Sincerely

R M Hill

Richard M. Hill
Manager
Inuvik Research Laboratory

RMH/nb

cc R A Hemstock - IOL
NCRC
cc to John Lyle.

1867 | 1967

John

This is the letter Dick Hall promised regarding the location and operation of our test pipeline. It should take care of the legal problems

Regards
Alex H.

NIGHT HOURS

es
iennes et
nadien

our file/notre doss
your file/votre doss
da

cing a pi
to evaluate the construction tech

Canada

16 June 1967 INUVIK NWT

Department of
Indian Affairs and
Northern Development

Ministère des
Affaires indiennes et
du Nord canadien

Regional Administrator
Dept I A & N D
INUVIK NWT

Attn: Regional Engineer

our file/notre dossier
your file/votre dossier
date

Experimental Pipeline Project Near Inuvik

The Imperial Oil research section are initiating a pipeline research program near Inuvik to evaluate the construction techniques and potential problems of an arctic pipeline.

In August of this year, they propose to lay around 2000 feet of pipe at a spot along the Inuvik airport road 2 miles southeast of Inuvik just past the CBC radio tower. The line would start at a highbank, cross a creek, go under the airport road, cut a corner of Gaynor's Lake, and extend into the high bank North of Gaynor's Lake.

This project will be operated in association with the Inuvik Research Laboratory for an approximate three year period. Imperial Oil will be responsible for laying the line with minimal disruption to traffic on the airport road and for essential cleanup when the project is completed.

While the project is underway, we would request minimal disturbance in the test area.

If you have any questions or suggestions on the project, please let me know.

Sincerely

R M Hill

Richard M. Hill
Manager
Inuvik Research Laboratory

RMH/nb

cc R A Hemstock - IOL ✓
NCRC
c.c. to John Lyle.

1867 | 1967

IMPERIAL OIL LIMITED
TELETYPE MESSAGE

1

1967 JUN 19 PM 12 57

C 6 CALGARY JUNE 19/67

9.666.E 8 copy
to 9.301

W J KEYS
T & S
TORONTO

REURTEL JUNE 16 CHARGES FOR ARTIC PIPELINE PROJECT #483 JANUARY - MAY 1967 $2,851.46. CHARGES ARE COLLECTED IN LABORATORY PROJECTS 3858 & 3859. UNDERSTAND BILLING WAS MADE FROM EDMONTON COMPTROLLERS DEPT. LAST WEEK AND WILL BE MADE MONTHLY HEREAFTER

RHT/ J W CAMPBELL

16 483 1967 2,851.46 3858 3859
PMP
8:58

DRUMMOND BUSINESS FORMS LTD.
FORM 2-5959

IMPERIAL OIL LIMITED

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION
E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE, EDMONTON, CANADA

June 16, 1967

Our File 37.37

Mr. K. R. Shipley,
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

Attention Mr. W. J. Keys

Re Arctic Pipelining, Project #483

Attached are two prints of the plan and profile of the route selected on June 12 and 13 for the proposed experimental pipeline near Inuvik, N.W.T. (Drawing F 10.759).

Copies of the same have been sent to Mr. R. A. Hemstock in Calgary.

If more prints are required, they are available upon request.

Yours very truly,

E. W. CHRISTIAN

John E. Lyle
J. E. Lyle

JEL/McB
Enc.

P/L DIVISION
FILE No. 9.666E
JUN 19 1967

	NOTE	ACT	INITIAL
KRS			
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CJB			
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CVH			
WJK	✓		

DATE ANS'D 1209.

IMPERIAL OIL LIMITED

June 16, 1967

Our File 37.37

Mr. K. R. Shipley,
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

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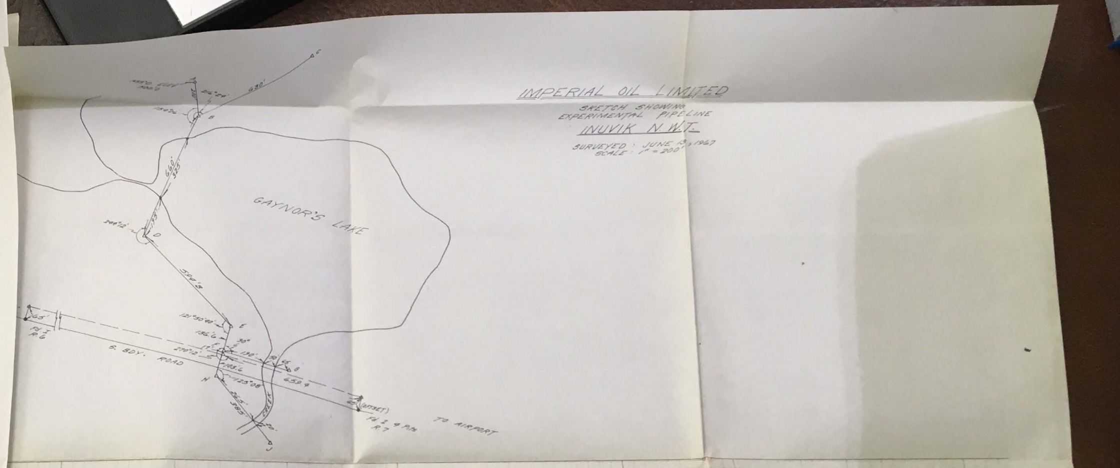
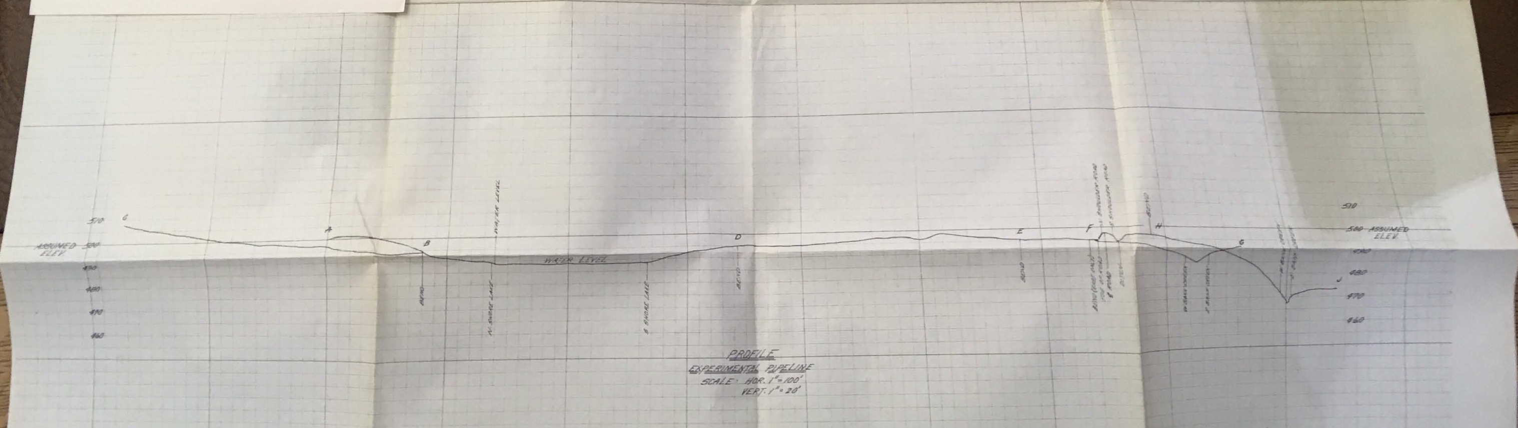
E. W. CHRISTIAN

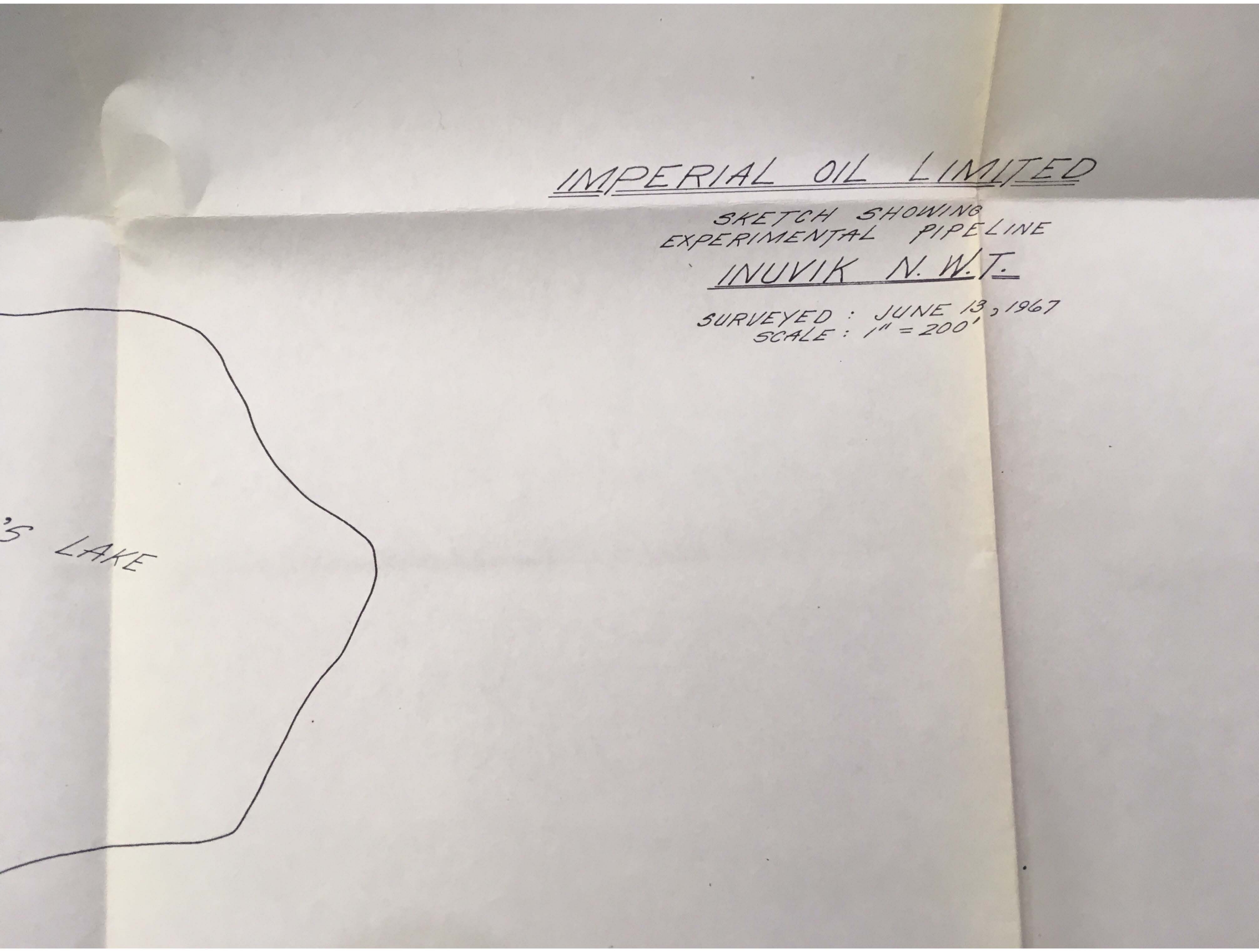
J. E. Lyle

JEL/McB
Enc.

P/L DIVISION
JUN 19 1967






IMPERIAL OIL LIMITED
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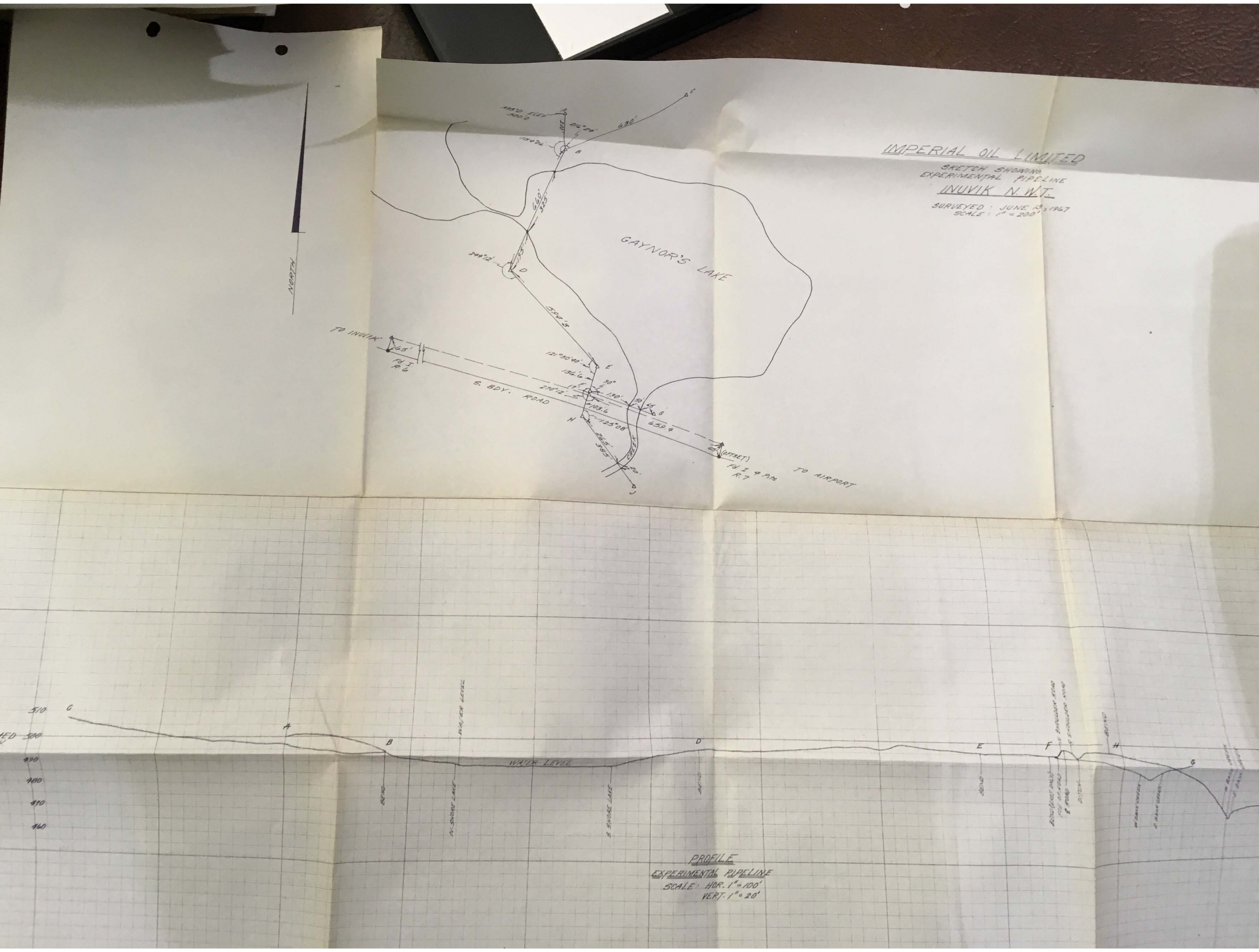
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SKETCH SHOWING
EXPERIMENTAL PIPELINE
INUVIK N.W.T.
SURVEYED : JUNE 13, 1967
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S. SHORE LAKE
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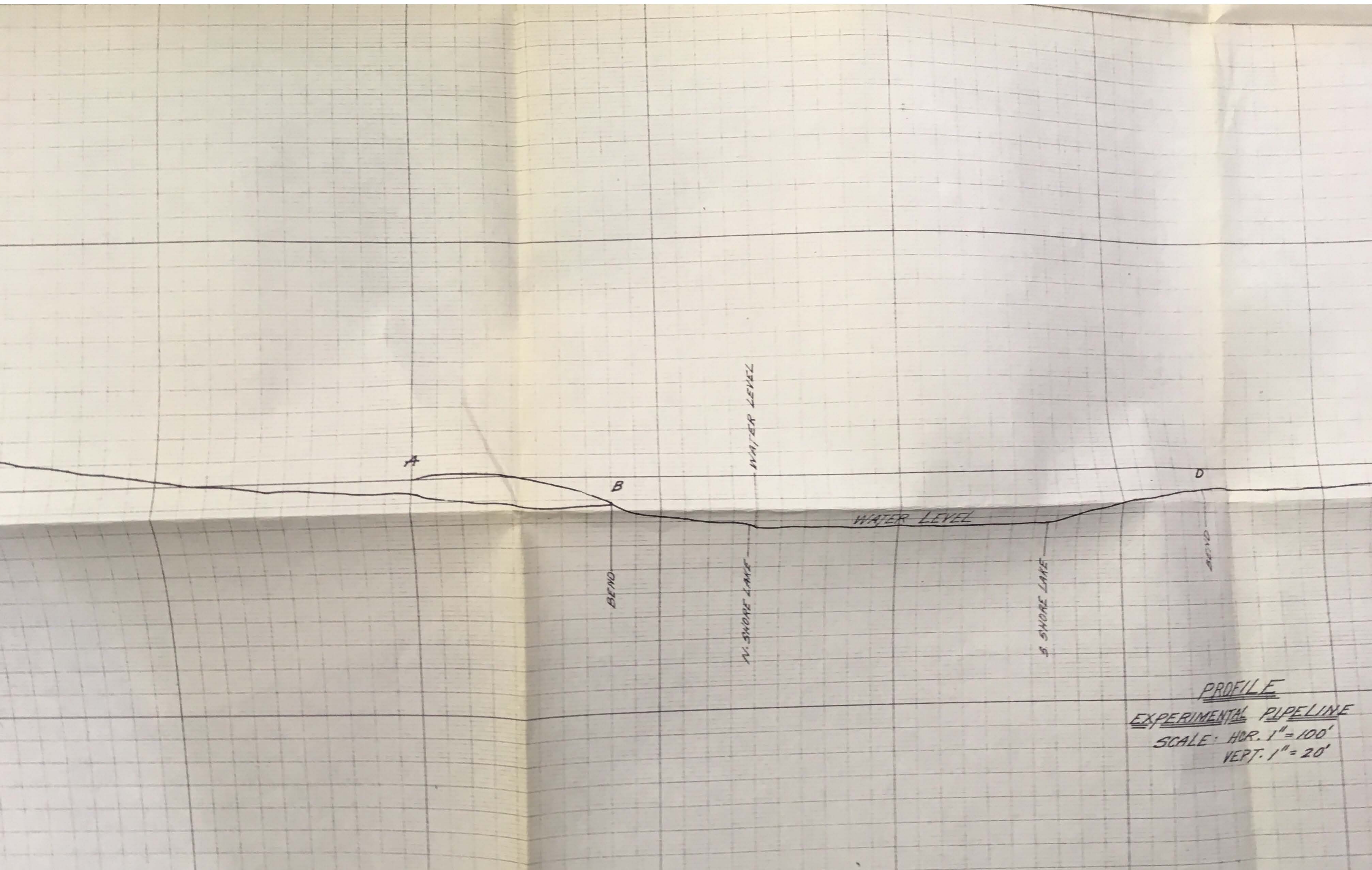
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S. SHORE LAKE
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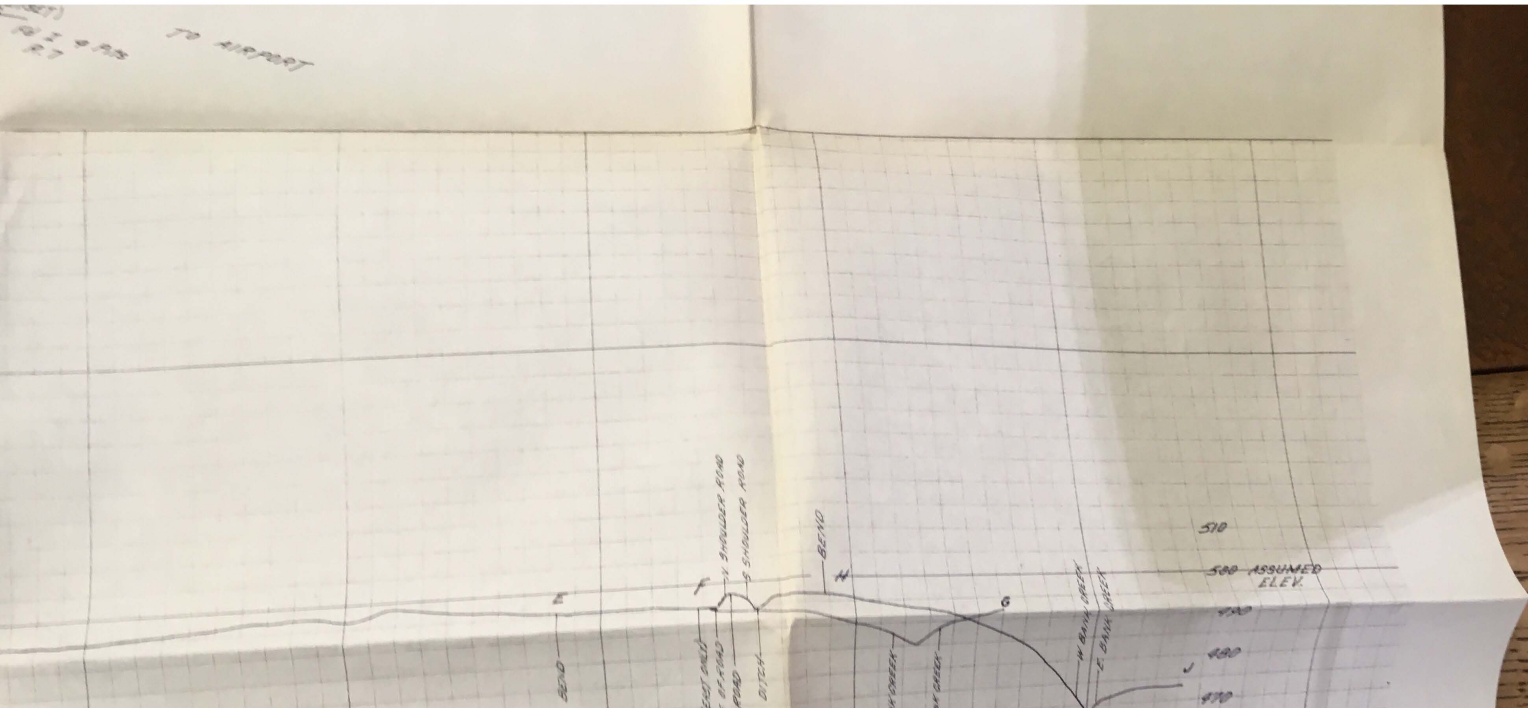
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1" = 100'
1" = 20'

PURCHASING DEPARTMENT

MEMORANDUM

June 16, 1967

File: 63.1
Arctic Pipe Line
Research Project #483
Your File: 9.666E

Mr. R. B. Spears
B u i l d i n g

Attention: Mr. K. R. Shipley (W. J. Keys)

In reply to your request of June 6th, please find attached copy of quotations from Prudential Steel Ltd., Interprovincial Steel and Pipe Corporation Ltd., The Steel Company of Canada Ltd., and Alberta Phoenix Tube & Pipe Limited covering requirements of pipe for the above project.

Please let us have your decision regarding procurement of this material as soon as possible in order that delivery dates can be maintained.

O. K. SMITH

By: J L Forrest
J. L. Forrest

JLF:MR
6/26

Attach.

P/L DIVISION
FILE No. 9·666E
JUN 19 1967

	NOTE	ACT	INITIAL
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DATE ANS'D	1196.		

Ordered from Phoenix.
WJK.

PRUDENTIAL STEEL LTD.
P.O. BOX 1510, CALGARY, ALBERTA. TELEPHONE 279-4401

June 12, 1967

Imperial Oil Limited
11160 Jasper Avenue
Edmonton, Alberta

Attention: Mr. D. D. Foster

Dear Sir:

Our Ref: P-301

We take pleasure in submitting our quotation to you as follows for your 6-5/8" x .125" and 3-1/2" x .125" requirements but must excuse ourselves from quoting on your Items No. 2, Alt. 2 and 3 as we do not manufacture these sizes.

MATERIAL

PRUDENTIAL radio frequency weld steel line pipe, manufactured to A.P.I. specifications, standard 5L grade B, weld zone normalized, double random lengths, ends bevelled for welding, bare metal finish.

Item No.	Outside Diameter and Gauge	Quantity Feet	Price per 100 Feet
1.	6-5/8" x .125"	1,200 - 1,600	78.73
2.	3-1/2" x .125"	2,500 - 3,000	42.71

Basis of Sale: F.O.B. truck, Edmonton, Alberta.

Prices: Include freight. Federal Sales Tax extra.

Delivery: Stock subject to prior sale.

We sincerely thank you for allowing us the opportunity to quote on your requirements and would very much appreciate receiving your valued order.

Very truly yours,

PRUDENTIAL STEEL LTD.

J. F. Wiles

J. F. Wiles
Sales and Traffic Co-ordinator

JFW/ekc

Prudential Steel Ltd.

CONDITIONS OF SALE

ne Seller referred to in these Conditions of Sale RUDENTIAL STEEL LTD. The Seller invites orders offers to purchase the products mentioned in the ched quotation subject to the following condis, which shall be deemed incorporated by refere in any Purchase Order. The Buyer's conditions purchase (if any) shall have no application tsoever to any contract or agreement between the ties except to the extent (if any) that the Seller ressly agrees in writing to any of such conditions.

PRICES: All shipments shall be billed at the ler's price or prices in effect at the time of pment. Prices shown on any price list or quotan or on any accepted order shall be adjusted to e effect to any industry-wide price increase made er quotation or acceptance of order which is in ect at the time of shipment. Any changes in nsportation charges included in delivered prices all be for the account of the Buyer and the selling ce adjusted accordingly.

QUOTATION BASIS: Unless otherwise stipulated the Seller all quotations and sales are for shipent f.o.b. at Calgary, Alberta. All quotations are biect to change by the Seller without notice, and e Seller shall have the right to correct any typoaphical or mathematical errors on any order or otation.

. **TERMS OF PAYMENT:** Net thirty days from date f invoice. Seller shall be entitled to charge interest the rate of seven per cent per annum on all verdue accounts after due date. All payments all be made at par at Calgary, Alberta. The uyer shall make such arrangements for payment as e Seller may from time to time require and the eller may suspend production, shipment or delivery f any products ordered by the Buyer until arrangeents satisfactory to the Seller to secure payment of e purchase price are made by the Buyer.

. **TAXES:** To the extent legally permissable, all resent and future taxes imposed by any Federal, rovincial, foreign or local authority which the Seller ay be required to pay or collect, upon or with eference to the sale, purchase, transportation, elivery, storage, use or consumption of products or ervices, including taxes upon or measured by the eceipts therefrom (except net income and equity ranchise taxes) shall be for account of the Buyer, nd all such taxes, unless otherwise expressly stiplated, shall be added to and become part of the rice payable by the Buyer to the Seller.

. **PURCHASE ORDERS:** Purchase orders are to be deemed effective and are to be construed as conracts only after approval and acceptance in writing by the Seller's office at Calgary, Alberta.

6. **TITLE:** Title to products priced at Seller's shipment point shall pass to Buyer upon delivery to the Buyer or to a carrier at such shipment point. Title to products priced at destination shall pass to the Buyer upon delivery to the Buyer or its agent at the destination specified, and any charges at destination for spotting, switching, handling, storage and other accessory services and demurrage shall be for the Buyer's account.

7. **RISK:** All merchandise shall be and remain at the risk of the Seller until, but not after, title thereto has passed to Buyer at which time Buyer shall assume all risk of loss or damage.

8. **DELIVERY DATE:** Delivery dates quoted show approximately the date or dates on or before which the products will be shipped from the Seller's mill. Seller shall exercise its best efforts to deliver within the time quoted but does not guarantee to do so, and shall not be held responsible for any loss or damage of any kind or nature whatsoever, and whether direct, indirect or consequential, caused by delay in delivery, irrespective of the cause of such delay.

9. **FORCE MAJEURE:** In the event of any delay in the Seller's performance due to fire, explosions, strike or other difference with workmen, riots, civil commotion, floods, storms, shortage of utility, facility, material or labor, delay in transportation, breakdown or accident, compliance with or other action taken to carry out the intent or purpose of any law or regulations or any course beyond the Seller's reasonable control, the Seller shall have such additional time within which to perform this contract as may be reasonably necessary under the circumstances and shall have the right to apportion his production among his customers in such manner as he may consider to be equitable, all without liability for loss or damage, whether direct, indirect, or consequential.

10. **SPECIFICATION:** Except in the particulars specified by the Purchasers and expressly agreed to in writing by the Seller, the products furnished hereunder shall be produced in accordance with the Seller's standard practices. All products, however, including those produced to meet an exact specification shall be subject to mill tolerances and variations consistent with good mill practice in respect to dimension, weight, straightness, section, composition and mechanical properties, and to normal variations in surface and internal conditions, and in quality; to deviations from tolerances and variations consistent with practical testing and inspection methods, and to regular mill practice on, over and under shipment.

11. **INSPECTION:** Where mill inspection is made by the Buyer, the Buyer's inspector shall be deemed the agent of the Buyer with authority to waive specified tests and details of test procedure and to accept products as conforming to this contract with respect to all characteristics of such products for which such inspection is made. Goods made to the Buyer's special specifications, where the Buyer is to inspect, must be inspected and accepted before shipment; if the Buyer fails to inspect before the time for shipment the Seller may nevertheless ship the goods and the Buyer shall be conclusively deemed to have accepted the goods.

12. **WARRANTY:** The Seller warrants that it has, in accordance with its usual practices, carefully inspected and tested the goods supplied. The foregoing warranty is given in lieu of all other waranties and conditions expressed or implied, statutory or otherwise, which are hereby excluded. The Seller shall not be liable to the Buyer for any damages, direct or indirect, arising out of the design, manufacture or delivery of the goods except as follows:

The Seller will replace such goods as proved defective in either material or manufacture prior to installation or allow credit for the price of such goods (including transportation charges) if any, paid by the Buyer at the Seller's option, provided that the Seller's liability shall not exceed the price and transportation charges aforesaid of the defective goods. No goods shall be returned except with the Seller's permission. Except as herein expressly stipulated the Seller shall not be liable to the Buyer for consequential damages.

13. **CLAIMS:** Claims for shortage or defective product or for incorrect charges must be made to the Seller within thirty days after receipt of the products by the Buyer. All products claimed to be defective shall be held by the Buyer subject to inspection by the Seller and products returned will not be accepted, credited or replaced unless arrangements for such return have previously been agreed to in writing to the railroad agent or to the carrier at destination as requested by the Conditions of Uniform Bills of Lading.

14. **PATENT INFRINGEMENT:** The Seller shall indemnify the Buyer for all direct and actual damages recovered from the Buyer by a third person in any legal proceedings for infringement of Canadian Patents by the products furnished hereunder. Provided that the Buyer promptly notifies the Seller of the claimed infringements, permits the Seller to assume the defence thereof and co-operates with the Seller with respect to such defence. In the event that products hereunder are produced under special designs and/or specifications of the Buyer not customarily followed by the Seller, no liability under this paragraph shall arise against the Seller, but the Buyer agrees to save harmless the Seller from Patent infringements resulting from the Seller's compliance with said special designs and/or specifications, originating with the Buyer.

15. **CONTRACT LAW:** These conditions and all matters pertaining to the contract of sale shall be construed in accordance with the laws of the Province of Alberta. Any provision hereof which is contrary to law shall not invalidate any other provision hereof. Any provision required to be included in a contract of this type by any applicable law or administrative regulation having the effect of law shall be deemed to be incorporated herein.

16. **WAIVER:** Waiver by the Seller or the Buyer of any breach of these provisions shall not be construed as a Waiver of any other breach.

17. **CANCELLATION:** Cancellation of any accepted Purchase Order is subject to written approval of the Seller.

18. **ENTIRE CONTRACT:** No terms or conditions, other than those stated herein, and no agreement or understanding, oral or written, in any way purporting to modify these terms of conditions, whether contained in the Buyer's purchase or shipping release forms, or elsewhere, shall be binding on the Seller unless hereafter made in writing and signed by his authorized representative. All proposals, negotiations, and representations, if any, made prior, and with reference hereto are merged herein.

ERPROVINCIAL STEEL AND PIPE CORPORATION LTD.

HEAD OFFICE
P.O. BOX 1670
REGINA, CANADA
569-0531
TELEX 031-2269

PIPE DIVISION

301

SALES OFFICE
XXPETRO CHEMICAL BUILDING
CALGARY, CANADA
AMHURST 2-3966
TELEX 038-2283

June 13, 1967.

Imperial Oil Limited
11160 Jasper Avenue
EDMONTON, Alberta.

Attention: Mr. D. Foster
Purchasing Department

Dear Sir:

Re: Your File ED 5014-F
Our Quotation No. C-4359

Thank you for the opportunity to quote on your line pipe requiremants for Edmonton, Alberta.

The material offered is High Frequency Electric Resistance Weld Line Pipe, manufactured in accordance with A.P.I. specification 5L, Grade B. The material can be supplied in double random lengths, ends bevelled for welding, bare metal finish. The longitudinal weld has been fully stress relieved by means of an induction type normalizing unit and completely checked by ultra-sonic inspection.

The following prices are F.O.B. Edmonton, Alberta. Federal Sales Tax is extra, if applicable.

1200 - 1600' - 6 5/8" O.D. X 0.125 wall X 8.68#/ft. API 5L B

F.O.B. Edmonton $78.12 per 100'

400 - 500' - 16" O.D. X 0.219 wall X 36.87#/ft. API 5L B

F.O.B. Edmonton $350.26 per 100'

700 - 900' - 10 3/4" O.D. X 0.188 wall X 21.15#/ft.* API 5L B

F.O.B. Edmonton $169.19 per 100'

* - We are taking the liberty of quoting on 0.188 wall, as this is the thinnest wall we can supply at the present time.

2500 - 3000' - 3 1/2" O.D. X 0.125 wall X 4.51#/ft. API 5L B

F.O.B. Edmonton $38.33 per 100'

Delivery of the above material can be made from stock.

We sincerely appreciate the privilege of quoting on your requirements, and hope to be of further service.

Yours very truly

INTERPROVINCIAL STEEL AND PIPE CORP. LTD.

L. G. Welch
Vice-President - Sales.

LGW/srm

THE STEEL COMPANY OF CANADA, LIMITED

STELCO

QUOTATION

Imperial Oil Limited 11160 Jasper Avenue EDMONTON, Alberta	OUR REFERENCE NO. C 20588 June 13, 1967
ATTN. Mr. D. D. Foster, Purchasing Agent	YOUR ENQUIRY ED-5014-F - Line Pipe

WE TAKE PLEASURE IN QUOTING THE FOLLOWING PRICES SUBJECT TO TERMS AND CONDITIONS STATED HEREIN.

DESCRIPTION AND SIZE	QUANTITY	PRICE PER 100 FEET
Stelco "CANADIAN MADE" Black Electric Resistance Welded Steel Pipe to A.P.I. Standard 5L Grade B, Double Random Lengths, Bevelled Ends, Bare Metal Finish		
3-1/2" O.D. x .125" wall x 4.51# per ft.	2500 to 3000'	$ 48.53
6-5/8" O.D. x .125" wall x 8.68# per ft.	1200 to 1600'	$ 82.37
Alt. 10-3/4" O.D. x .250" wall x 28.04# per ft.	700 to 900'	$280.31
Alt. 16" O.D. x .250" wall x 42.05# per ft.	400 to 500'	$459.79
Stelco "CANADIAN MADE" Electric Fusion Welded Steel Pipe to A.P.I. Standard 5L Grade X-42, Double Random Lengths, Bevelled Ends, Bare Metal Finish		
Alt. 20" O.D. x .250" wall x 52.73# per ft.	400 to 500'	$863.82

TERMS: NET THIRTY DAYS FROM DATE OF EACH SHIPMENT	F.O.B.	FED. SALES TAX	PROV. SALES TAX
X	Cars - Edmonton, Alberta	Extra	Extra

DELIVERY AND REMARKS

Delivery: from stock ex Welland. For item 6", lengths 45 to 50 ft. from stock. Lengths 38 to 42 ft. from rolling June 15 for order placed no later than June 14.

UNLESS OTHERWISE STATED, ALL QUOTATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE. ORDERS ARE SUBJECT TO OUR CONDITIONS OF SALE AND ARE ACCEPTED AT THE SELLER'S PRICES AND THE TRANSPORTATION CHARGES PREVAILING AT DATE OF SHIPMENT.

THE STEEL COMPANY OF CANADA, LIMITED

J W McReynolds

J. W. McReynolds, P. Eng.
Sales Manager, Western Region
TUBULAR MILL PRODUCTS

KEB:IC

ALBERTA PHOENIX TUBE & PIPE LIMITED

SALES OFFICE
PHONE 263-6890 • 620 BENTALL BLDG
CALGARY, ALBERTA, CANADA

June 12, 1967

Imperial Oil Ltd.
11160 Jasper Avenue
Edmonton, Alberta

Attention: Mr. D. Foster

Our Quotation No. C-3584

Dear Sirs:

Re: Your inquiry file ED 5014 F

In reply to your request for prices, we are pleased to quote as follows:

ELECTRIC RESISTANCE WELDED STEEL LINE PIPE									
ITEM No.	QUANTITY FEET/TONS	O.D. & WALL THICKNESS	THEO. WT PER FT. LBS.	GRADE	SECTION LENGTH	END FINISH	COATING	PRICE PER 100 FEET	
								RESALE	JOBBER
1	1000	6 5/8 x .125	8.68	B	DR	BE	Bare	74.76	
2	500	20 x .250	52.73	B	DR	BE	Bare	825.73	
ALTERNATES									
3	500	16 x .188	31.75	b	DR	BE	Bare	274.32	
3 alt	500	16 x .219	36.87	"	"	"	"	318.56	
4	900	10 3/4 x .188	21.15	"	"	"	"	182.74	
5	3000	3 1/2 x .125	4.51	"	"	"	"	38.84	

BASIS OF SALE: F.O.B. car/truck. EDMONTON

FREIGHT RATE: per 100′/Cwt. To

In the event any other point of delivery is required, prices are subject to revision.

Prices exclude/~~include~~ Federal Sales Tax.

Prices will be those in effect at time of shipment.

DELIVERY: Stock subject to prior sale.

We thank you for your inquiry and hope we will be favored with your order.

Yours very truly,
ALBERTA PHOENIX TUBE & PIPE LIMITED

K. R. Woodman

K. R. Woodman, Sales Office

KRW/gr

LIMITED

PRODUCTION RESEARCH AND
TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT
R. H. TESKEY
MANAGER

339 - 50TH AVENUE SOUTH EAST. CALGARY. ALBERTA

P/L DIVISION
FILE No. 9.666E
JUN 8 1967

	NOTE	ACT	INITIAL
KRS			
CC	✓		cc
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓	✓	WJK

DATE ANS'D 11/8.

June 6, 1967

l Supply Dept.
ed
W.

Attention: Mr. W. J. Keys

e: Arctic Test Pipeline - Project No. 483
Strain Gauge Application

Attached are three copies of Laboratory Report No.L-36967, discussing the above proposal.

Cost details are included and total $15,500. This figure covers strain gauge, thermistor and cathodic protection measurement requirements with the exception of rental on one welding machine having a 110 AC outlet power facility.

Materials which will require extended or uncertain delivery, have been ordered.

Strain gauge delivery is not firm and is estimated 6 - 10 weeks. Since this is a $6,000 item, the order has not been placed and awaits your negotiations with Esso, N.Y.

Remaining apparatus is stock and has up to 3 weeks' delivery.

Attached is a general detail of gauge and station locations on the line profile. These locations will naturally be dependent upon the final line location.

We consider the use of uncoated line pipe desirable from the information standpoint.

..../2

IMPERIAL OIL LIMITED

PRODUCTION RESEARCH AND
TECHNICAL SERVICE LABORATORY

WESTERN REGION PRODUCING DEPARTMENT

R. H. TESKEY
MANAGER

339 - 50TH AVENUE SOUTH EAST. CALGARY. ALBERTA

June 6, 1967

Mr. K. R. Shipley
Manager
Transportation and Supply Dept.
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

Re: Arctic Test Pipeline - Project No. 483
Strain Gauge Application

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We consider the use of uncoated line pipe desirable from the information standpoint.

../2

The line location will quite rightly be determined firstly on the basis of terrain, however to facilitate readings during severe weather, consideration should be given to a route which would approach the highway as closely as possible.

The information received from ERE, and particularly T. J. Atterbury and his group at Battelle, has been found to be indispensable. Their assistance and cooperation has made this project possible. A letter to this effect has been forwarded to both groups.

Details of line location will be finalized early in the week of June 12 following a field trip to the area by Mr. W. J. Keys, R. A. Hemstock and representatives from Construction and Production Research and Technical Service Laboratory.

Please advise if any further detail is required.

Yours very truly

R. H. Teskey

attach.
CD/mt

cc: R. A. Hemstock
L. W. Whitmer
W. R. Evans
File 662
day

LABORATORY REPORT NO. L-36967

THEORETICAL PIPELINE STRESS ANALYSIS
TEST INSTALLATION - PROJECT 483
ARCTIC PIPELINE

Reference: Letters K. R. Shipley / W. John Keys to R. H. Teskey / R. A. Hemstock, May 5, 11, 1967 arranging a familiarization tour of ERE and Battelle.

The tour was carried out May 15 through 19, 1967.

Conclusions

1. The use of strain gauge techniques can be made in this hostile environment with some inconvenience and additional cost of invested equipment

2. Actual installation of gauges will be a field operation and selection of points has been done with reference to the drawing provided by Pipe Line Division.

3. The Budd strain measurement, digital, unit has been selected in preference to BLH and other units because of its increased portability, accuracy, simplicity and operability. It is completely portable but will require a warm box for winter operation. This is unavoidable with any of the instruments considered.

4. Strain gauges were selected on the basis of ease of application and durability. The Microdot units selected are welded in position and are encased in stainless steel foil. This gauge type obviates difficult application, adhesion and moisture proofing.

The technique will allow similar mounting procedures to be used for thermistor stations along the line.

5. Strain gauge, thermistor and cathodic protection measurements will be taken at the suggested points of changes in "cover." Installations are more involved at anchor and crossing points as a result of the complex forces anticipated.

6. Thermistors will be mounted on top and bottom surfaces to determine temperature gradients in the covered sections.

7. Cathodic protection test leads will be located at the 'Stations' shown in the attached figure.

8. All readings will be conducted at the terminal boxes located at each of the 10 stations shown.

9. Estimated cost not included is the rental of one welding machine having 110 V AC output taps, stinger and box of welding rod.

$15,500

../2

Details

1. Gauge Selection

As a result of the real possibility of application being made in the field during difficult weather conditions and since a considerable effort is being made to make this a comprehensive study, the integrity of the gauges must be guaranteed. The gauge selection resolved finally into the use of the weldable type. The added cost of purchase will be defrayed by the much reduced cost of labor connected to installation and the application will be 'permanent.' Life of the installation is thus not critical and may actually be in excess of the 2-year expectancy.

The critical requirements are these, in summary:

1. an absolutely clean, white-metal surface;

2. perfect gauge-surface contact; and

3. absolute moisture impermeability throughout the circuit.

Surface preparation can be made using a small pencil grinder powered on 110 volt AC from a welding machine.

Gauge application is achieved using the Microdot welder and Weldmatic power supply driven again by 110 volt AC from a welding machine. The gauges have been located at various points along the line which are considered of interest. Also at these points, temperature measurements will be taken using thermistors installed on both the top and bottom of the line.

A test lead will also be installed for the purpose of evaluating pipe-soil potentials, line crurents and gauge-pipe resistance.

Gauges are located in such a way as to provide hoop, longitudinal and bending strain measurement.

Temperature compensation of the gauges is such as to minimize differences in thermal expansion between gauge elements and the pipe. A precise correction factor is applied in the final analysis.

The gauges are permanently sealed, as are the short lead wire connections. The lead wires (sheathed in a stainless steel tube) are soldered to the 3-wire cable which is, in turn, encased in an aluminum sheath. The connection will be made within a moisture-proofed junction box. Junction box, lead wire sheath and aluminum-jacketed cable will be strapped to the line as will the thermistor and cathodic measurement leads.

../3

All wires will be brought above ground at several stations along the line. At the station, a pole-mounted, moisture-proofed, terminal box will be located and each of the strain gauge and thermistor leads will be individually installed.

Use of the amphanal connectors having gold-plated contacts is required on each connection to the strain gauges. Gold plating is not required on the thermistor or cathodic measurement test points.

Strain measurements will be made using the Budd, portable instrument. During winter months, a warm box will be required to assure its proper operation. A single plug-in type connection from the instrument to the strain gauges will be provided. The instrument will have a fixed setting which can be checked readily. Only one adjustment will be required to null the bridge circuit and obtain the digital strain reading. Compression and tension are signified by a - and + sign, respectively, which appears on the digital read-out.

Two instruments are required in order to assure integrity of the system, particularly in view of the remote location.

An added cost is required for the instrument packages to reduce temperature effects on the zero sensitivity of the bridge circuit. This will provide the necessary accuracy for reduced temperature operation.

The warm box construction will depend upon the final line profile since travel modes will be involved. If a Ski-do is used, the box can be warmed by either exhaust or by a small cat. heater. The box itself could be arranged to allow manipulation of the balance knob from outside the box while observations are made through a thermo-pane window. The instrument could thus be left permanently on the machine.

Temperature readings will be carried out using existing instrumentation which is probably not adequate for future needs since it has a low upper temperature limitation. For current needs, however, the existing units are adequate.

Cathodic measurements will be made on a spot-test basis by Laboratory personnel using existing equipment.

Data processing will be computerised. A programme is in preparation at the present time using a sample format received from Battelle.

Laboratory Tests

Laboratory testing will be required to finalize the following points:

1. Considerable test welding using the microdot sample strips will be required to determine machine settings and operating practices to guarantee acceptable welding of the gauges to the line under various conditions of ambient temperature (+60 to +20°F).

2. To minimize field work requirement pre-assembly of as much apparatus as possible is desirable, i.e. terminal boxes, junction boxes, thermistor connections.

3. Thermistors will be applied to thin stainless foil. The foil will be field-welded to the line in the same way as the strain gauges. Application techniques will have to be established for getting the thermistor elements bonded to the foil.

4. Arrangement of the gauges, thermistors and cathodic test leads will have to be made such that protection can be applied to the installation. Various means of moisture proofing must be evaluated to develop the most practical means of field application.

ATTACH's

COLIN DUNCAN
Production Research &
Technical Service Dept.
Calgary - Alberta

JUNE 5, 1967

COST ESTIMATES*

	Item	Quantity	Cost $Canadian
1.	Microdot Rollectrode Model M7-809	(1)	900
2.	Unitek Weldmatic Power Supply Model 1-048-02-02 with blower	(1)	1,000
3.	Budd Portable Strain Gauge Instrument Model P-350 w/counting balance knobs	(2 @ $900 ea.)	1,800
4.	Microdot Weldable Strain Gauges Model SG 122, 321 S.S. flange having 6" integral lead, configuration V11, compensated for temperature range -65 to 250°F, option 3, and apparent strain option A.	(120)	6,000
5.	Thermistors	(40 @ $5.00 ea.)	200
6.	Junction Boxes	(120)	200
7.	Terminal Boxes	(12 @ $25.00 ea.)	300
8.	Connectors - Amphenal		
	a. Strain gauges (gold plated)	(120)	1,500
	b. Thermistors	(40)	400
9.	Connectors - Conduit		500
10.	Cathodic Protection Test Lead Wire		50
11.	Three wire conductor, sheathed in aluminum tubing all PVC insulated.		2,000
12.	Metal Strapping (strapping machine available)		50
13.	Welder's Wind Screen	(2)	300
14.	Hand Grinder (110 V AC)		70
15.	12 lengths, 2" sch 20 pipe in 8' lengths		50
16.	Metal gauge protectors	(100)	25
			$15,345

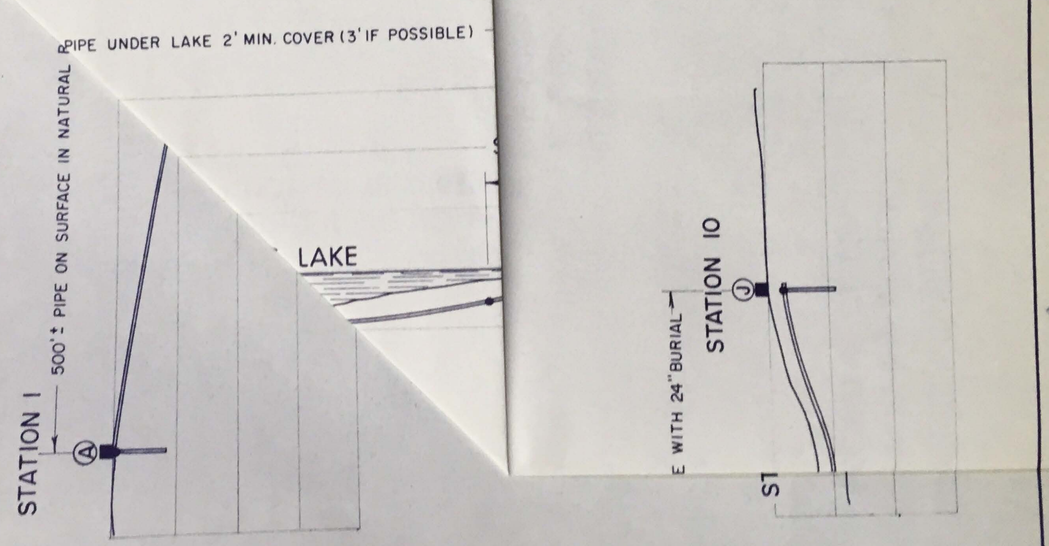
*Estimates do not include:

1. rental of 1 welding machine capable of 110V AC output to max. of 10 - 20 amps.
2. propane torch and rosebud.
3. stinger, welding rods.
4. means of driving 2" O.D. pipe stubs into the permafrost for anchor posts to which terminal boxes will be mounted.

PEOPLE CONTACTED

ERE	Jim Payne	- Strain Gauges
	Ray Chao	- Strain Gauges
	Ron Klotsky	
	Harry Ebert	- Welding
Battelle	Tom Atterbury)	
	Nelson Crites)	
	Roger Wright)	- Strain Gauges
	Roscoe Smith)	
	Don Lyons)	
	Robert Monroe	- Welding
Budd	Joe Hastings	- Instrumentation
	(Richard Becker)	
Microdot	Albert Bezdjian	- Gauges
	Bob Brennan	- Sales Manager
William T. Bean Inc.	Lee J. Waymouth	- Gauges and
	Robert Whitehead	general
	Bruce Davey	discussion.

RAIN GAUGE LOCATIONS
TEST LINE PROFILE



June 6, 1967

Arctic Pipe Line Research Project #483
File: 9.666E

Mr. C. W. E. Miles
Purchasing Department
Building

Attention: Mr. J. L. Forrest

As part of this project it is planned to install a section of pipe line during the late summer of 1967 in the Inuvik area. The purpose of this installation will be to determine stresses imposed on the pipe due to extremes of temperature and terrain, as has been discussed briefly with you earlier.

Pipe and fittings for this work will have to be moved out of Edmonton, presumably by Northern Alberta Railways to Hay River and then by barge up the Mackenzie River to arrive on site during first two weeks of August. It is desirable that pipe be relatively mild steel, such as Grade B and thin wall. The following are the approximate sizes, wall thickness and range of quantities required:

Quantity	Size	Wall Thickness	Grade (Preferred)
1. 1200-1600 feet	6.625" O.D.	.125	B
2. 400-500 feet	20.0" O.D.	.219 to .250	B
OR " "	16.0" O.D.	.188 to .219	B
3. 700-900 feet	10.75" O.D.	.125 to .156	B
4. 2500-3000 feet	3.50" O.D.	.125	B

For barge shipping and handling and because there will not be much heavy equipment available to install this, it is likely that lengths of 38 to 42 feet would be desirable for the pipe. In addition some 150# ASA fittings, valves, etc. will be required in the above sizes.

Please establish availability, cost and source of these materials. It is anticipated that most of this will be available from stock since there is reasonable flexibility in the grade, etc.

K. R. SHIPLEY

By: ____________________
W. J. Keys

WJK/sr

V

TELET

CN TEL TOR TM

IMPOIL TOR

1967 MAY 12 PM 3

CNT TXM116 18/15 TLX COLUMBUS OHIO MAY 12 201P EST

9.666.E

W J KEYS IMPERIAL OIL CO LTD

TORONTO ONT

CONFIRMING RESERVATION FOR COLIN DUNCAN AT STOUFFER'S MOTOR INN FOR MAY 16, 17, AND 18

T J ATTERBURY BATTELLE MEMORIAL INSTITUTE

16 17 18

Passed on May 12/67 to
Colin Duncan
Calgary
WJK

317P EDT

CN TEL TOR TM

IMPOIL TOR

INVOICE

Battelle Memorial Institute
COLUMBUS LABORATORIES

JUN 22 1967

505 KING AVENUE   COLUMBUS, OHIO 43201

IN ACCOUNT WITH

Imperial Oil Limited
Transportation and Supply Dept.
111 St. Clair Avenue West
Toronto, Canada

Attn: Mr. K. R. Shipley, Manager

INVOICE NO.
A 4645

YOUR ORDER NO.

Ref: Research
Project # 483

TERMS: NET UPON PRESENTATION OF INVOICE

PROJECT NO.		AMOUNT
7-600	Costs incurred in training Mr. Colin Duncan on the selection, utilization and installation of strain gauges onpipe.	513.79

Approved for payment
June 26, 1967
H. J. Keys.

May 11, 1967

Re: Course on Strain Gauge

File: 9.666E

Battelle Memorial Institute
505 King Avenue
Columbus, 1. Ohio.

Attention Mr. Tom Atterbury

Dear Sir:

This letter will confirm our telephone conversation of May 10, 1967 wherein it was agreed that you could accomodate our Mr. Colin Duncan for three to four days beginning May 16, 1967 for instruction on the selection, utilization and installation of strain gauges on pipe.

As discussed, this training course will be conducted on a rather informal basis which, we feel sure, will be most acceptable to Mr. Duncan, thereby allowing him to inquire into the areas of most interest and concern to him.

It is agreed that you will invoice our Company on the basis that charges will be formulated on a consultative principle covering engineer's services plus overhead, even though there has not been any finite amounts established regarding fees. We fully realize the necessity of this approach in view of the expediency and also the general and informal nature of the training. When submitting these charges please refer to our Research Project #483.

We thank you for according us this opportunity, particularly on rather short notice and feel sure it will be of benefit to us.

Yours very truly,

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.

cc. Mr. R.A. Hemstock, Calgary.

May 5, 1967

Re: Arctic Pipe Line Research - Test Installation

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
Western Region Producing Dept.
339 50th Avenue S.E.
Calgary, Alberta.

Attention Mr. R.A. Hemstock

Dear Alex:

We have attached hereto, three copies of our drawing #2 on Proposed Test Site Layout for Project #483. This is based on the site sketch you provided and the layout as prepared in our earlier meeting. Using assumed elevations, this drawing was prepared to use as a basis for the survey, construction planning, estimating and for your plans on location, type and installation of strain gauges.

Referring to the drawing and, as discussed, we may not cross the road but this is subject to more definite plans when survey is being completed. However, if we have equipment available, it would be desirable to include this as part of the test.

Please mark up a copy of this if you feel that an alternate layout is preferable and be assured any suggestion in this regard is welcome. This includes any changes in excavation or extent of cover.

As soon as possible we will have to put together cost figures on material, test equipment, construction and testing work after installation. As covered in our telephone conversation, it is requested you look at the cost of test equipment, gauges, installing gauges, etc. It is realized that construction will be a problem and estimating the cost of this to any substantial degree of accuracy will be very difficult.

We will leave it up to you to make preliminary contact with your people in Edmonton re. survey personnel. Regarding construction equipment, it will be beneficial to have a "cat" there, regardless of how it is equipped, if this is feasible in the moving of your equipment. It certainly appears that most of the work will be manual and this, as you point out, may be desirable to avoid excessive disruption of surface conditions during construction.

r. R.H. Teskey/R.A. Hemstock May 5, 1967

As of this morning, we have reviewed with our New York office, the possibility of your man spending a few days at Battelle and we will advise you of this by telephone as soon as a reply is received.

Yours very truly,

K.R. Shipley,

By:___________________________
W. John Keys.

WJK/EG

attachs.

MEMORANDUM

TRANSPORTATION AND SUPPLY DEPARTMENT
PIPE LINE DIVISION

April 28, 1967

Re: Strain Gauge Installation

File: 9.666E

TO FILE:

Mr. Lionel Morrow called today to advise that through contacting Mr. Fred Stracke, who is pipe line research contact in Esso Research and Engineering, he has been advised that a Mr. Fred Guber has had considerable experience in strain gauge selection, utilization and installation. He is located at Florham Park, telephone ext. 6186.

Mr. Morrow has not contacted him but has left this to our own discretion if we feel his help is needed. He suggests we discuss it with him to determine his availability and experience.

W J Keys

W.J. Keys.

WJK/EG.

April 27, 1967

Re: Test Installation - Project #483 - Arctic Pipeline Research

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
Western Region Producing Dept.
339 50th Avenue S.E.
Calgary, Alberta

Attention Mr. R.A. Hemstock

Dear Sir:

We wish to thank you for your letter of April 18, 1967 and attached sketches of the proposed site near Gaynor's Lake along the Inuvik town to airport road. This looks like a very satisfactory location covering the various aspects that have been outlined in our earlier proposal.

On the basis of this site area we are presently preparing some detailed sketches on the pipeline installation which we will submit to you as soon as completed. These will serve as a basis, subject to modification after survey has been carried out. On this basis we will also be considering means of constructing this installation since, as you point out, neither equipment nor manpower is readily available.

In discussions with Mr. Lionel Morrow who has taken over from Harry Cook as Pipe Line Research Manager and with Mr. R.L. Bullock of Humble, two matters have come forward regarding this research. First it is felt that, if possible, we should plan to initially install a return line so that oil (probably diesel) can be circulated and, if necessary, heated before circulation. We are considering this in our sketches and it appears that about a nominal 3" line would be adequate. It is their general feeling that this approach deserves evaluation so the line could be put in though it may not be filled or used initially. By the way, do you recall if there is a power line from the town running adjacent to the road for the C.B.C. transmitter and for airport facilities? This might be useful for a small pump installation.

Secondly, both Mr. Bullock and Mr. Morrow feel it is very essential that every possible exigency re. strain gauge utilization and installation be know prior to the installation. As you point out, you have had experience on casing in severe environments so the techniques are not completely new by any means. However, in view of the concern over this and the very nature of the installation, it is

Mr. R.H. Teskey/Calgary. April 27, 1967

certainly essential to insure the best know-how is employed.

In this regard there are several avenues open to consideration. First, as has been considered, is the enrolling in a seminar when available by the engineer or technician who will be involved. Secondly, some personnel in Esso Research and Engineering have had experience along these lines and may be able to advise and assist. Thirdly, Battelle Memorial Institute have done very extensive work on pipe line strength testing including branch connection design for the A.P.I. and the A.G.A. and this test work involved innumerable strain gauge installations. Battelle are located in Columbus, Ohio. It is not known what they could do to help but they could be approached from one of two ways: to instruct and advise a man sent there for a few days or to provide a man to consult and advise when our plans are further advanced. Fourthly, to use the services of an agency who can competently consult on this matter, preferably in the West if available, or a company such as one of those included in information forwarded to you, who supply equipment and, it is understood, also provide service for installation and testing.

We shall be calling you next week and can discuss the above aspects and also some points regarding the test installation site. Again, we wish to thank you for your work in selection of the site and we are pleased that Mr. Hill has so kindly extended his co-operation.

Yours very truly,

K.R. Shipley,

By:________________________
W. John Keys.

WJK/EG.

PURCHASING DEPARTMENT

MEMORANDUM

April 13, 1967

File: 5025-ABT
Ditching In Permafrost

Mr. R. B. Spears,
B u i l d i n g .

Attention: Mr.K.R.Shipley/J.Keys

We attach a copy of Link-Belt letter of April 11 together with some technical brochures all of which have been submitted to our enquiry under the above heading.

This quotation is not satisfactory and is sent along to you only for information.

O. K. SMITH

Per

A. B. Taylor

ABT:MC
4/28

Attach.

P/L DIVISION
FILE No. 9.666E
APR 14 1967

	NOTE	ACT	INITIAL
KRS			
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RAP			
LDA			
SMB			
CJB			
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CVH			
WJK	✓		

ANS'D 718.

1.

LINK-BELT SPEEDER (CANADA) LTD.

A complete line of shovel-cranes with Speed-o-Matic power hydraulic control

TELEPHONE 539-9844
TELEX 024-7410

P.O. BOX 190
WOODSTOCK, ONTARIO

April 11, 1967

50x8'
Ditching in permafrost

Imperial Oil Limited,
111 St. Clair Avenue West,
Toronto, Ontario.

<u>Attention:</u> Mr. O. K. Smith,
Purchasing Agent

Dear Sir:

Your letter of February 15 has been forwarded to us for handling by our Executive Offices in Chicago.

We are enclosing a "general line" catalogue, LS-78 Pipeliner catalogue, along with a catalogue on our new model 440 diesel pile hammer, to acquaint you with the types of equipment we manufacture. We are well known in the pipeline construction industry and at the present time all major pipeline contractors in the United States and Canada are using some Link-Belt backhoe equipment.

The pipeliner type backhoe is used, of course, wherever the going gets too tough for conventional trenchers and our machines have been used with success in the excavation of permafrost. The machines are used in a hacking or chopping action, and needless to say, progress is considerably slower than what one would expect under normal digging conditions.

Here at the factory we are rather unknowledgeable in regard to the amount of progress normally expected when excavating permafrost as opposed to normal digging conditions. We might suggest, however, that you investigate the possibility

-continued-

LINK-BELT SPEEDER (CANADA) LTD.

SHEET NO. 2
DATE April 11, 1967
CONTINUATION OF LETTER TO Imperial Oil Limited

of adapting one of our diesel pile hammers for use as a "chisel" in breaking up the ground before excavating with a conventional ditcher or backhoe. Certain companies have modified and adapted our hammers to a mounting on the back of a truck or tractor and then by using a special chisel point type of attachment, travelled along breaking the ground up as they go. We are not recommending this procedure to you as we are not familiar with your job requirements, but we simply suggest it as food for thought.

Our vice president for manufacturing at our U. S. plant, who had considerable experience working with permafrost during the construction of the Alcan Highway, advises us that they either took the expensive way out by dynamiting the permafrost loose or if possible filled in over the permafrost.

If we can be of any further help to you please feel free to get in touch with us directly or with our distributor:

Equipment Sales and Service,
1030 Martin Grove Road,
Rexdale, Ontario.

Telephone 249-8141

Yours very truly,

LINK-BELT SPEEDER (CANADA) LTD.,

Terry V. Stephenson

Terry V. Stephenson,
Sales Manager.

/db
encls.

IMPERIAL OIL LIMITED

PRODUCTION RESEARCH AND TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT
R. H. TESKEY
MANAGER

339 - 50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

April 18, 1967

Re: Project 483 Arctic Pipeline Research

Mr. K. R. Shipley
Imperial Oil Limited
Transportation and Supply Dept.
Pipe Line Division
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

On April 12, an evaluation was made of various possible sites for the proposed pipeline test near Inuvik. The sketch prepared by Mr. Keys for our meeting of March 22 was used as a guide in choosing the terrain types to be tested.

The attached sketch map shows what we believe to be the best location in the immediate Inuvik area. Mr. R. Hill who is manager of the N.R.C. laboratory at Inuvik was very helpful in locating the site and confirmed that there would be no problems in getting clearance to build the pipeline at the site. He also could see little chance of the site being disrupted for any other purpose in the next few years.

The pipeline centre line would cross the airport road a few hundred yards toward the airport from the CBC transmitter. It would begin (and be anchored) on high ground to the north where the cover is mainly spruce with some willow and birch. Trees are 10 - 20 ft high. It would proceed south across a corner of Gaynor Lake where accurate depth and temperature measurements are available from research by Dr. R. McKay on heat balances. The road could be crossed if desired then the pipeline carried on across a small creek to an anchor on high ground at the south end.

The cover types well represent those that would be encountered on any pipeline in the Arctic. Access to instrumentation sites would be very easy from the airport road.

../2

We are concerned about the lack of equipment and labor in the Inuvik area, however. There is available a small backhoe on rubber, a small dragline and one welder. It is doubtful if a D8 cat could be found although if we knew in time one could be moved in from Producing's wellsite at Tree River further up the Mackenzie. One or two Nodwell track vehicles are available. There is no pipe bending equipment and no ditcher of any kind, and labor is hard to get and most unpredictable. I believe that with such a short line it might be cheaper and more representative of the final job if the pipeline ditch was dug by hand. Only the part with 24" cover would be in ice and it could be blasted.

We would suggest that a pipeline engineer, together with a surveyor should go to Inuvik after the snow has gone - say mid-June and select and survey the pipe centre line in detail and make firm commitments for equipment and labor. The surveyor could probably be obtained from Producing or Exploration in Edmonton. I will follow this up if you wish.

With regard to your letter of April 12, we believe that the staff here at the Producing laboratory will be able to look after the details of the strain gauge installation. We have had some experience with instrumenting casing in severe environments and do not foresee serious difficulties. On the other hand, we would appreciate advice and suggestions from anyone familiar with pipeline instrumentation.

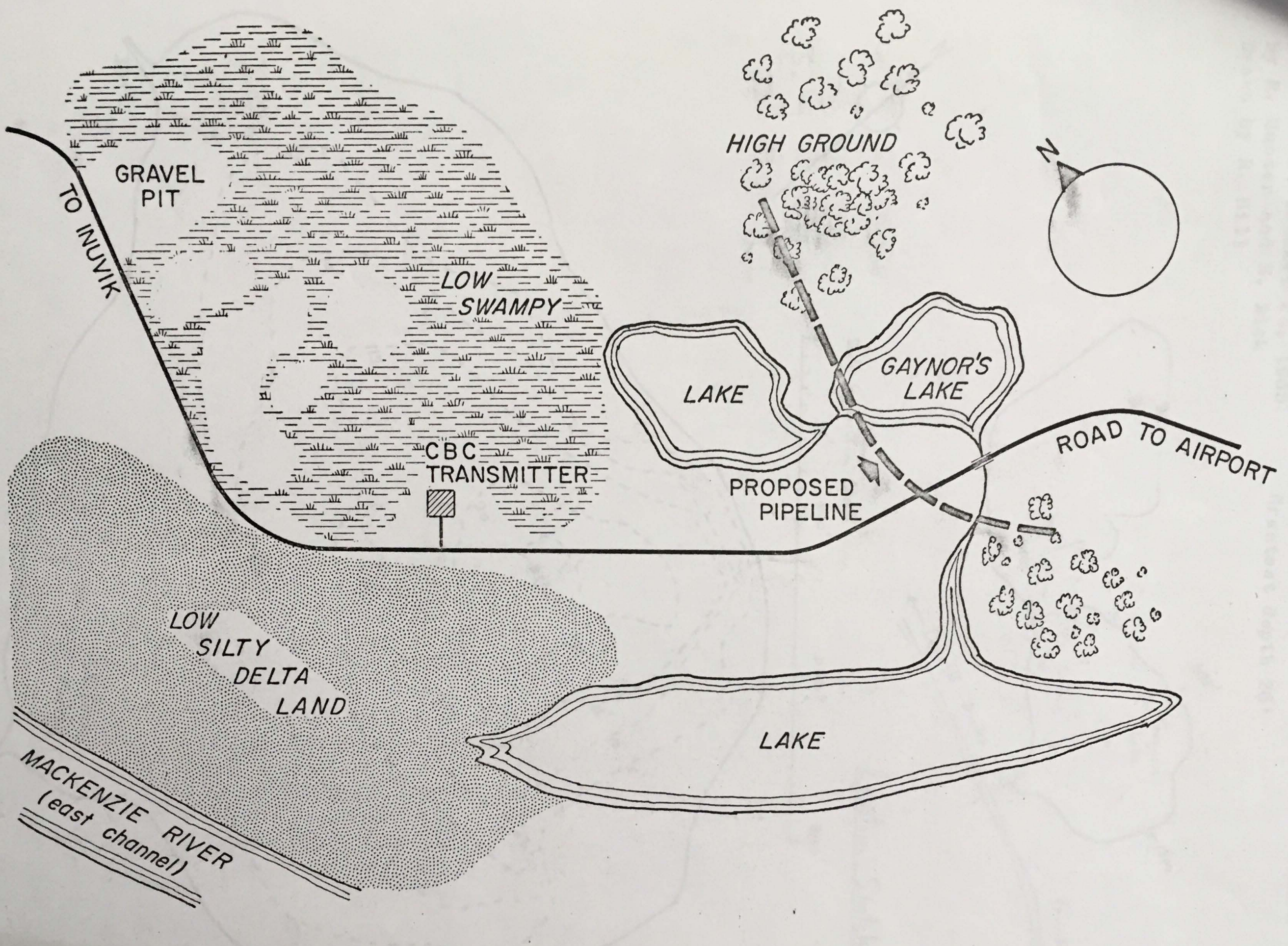
Mr. Hill is most interested in the project and has promised us his full cooperation.

Yours very truly

R. H. TESKEY

By R A Hemstock
R. A. Hemstock

RAH/mt
attach's
cc: G. Rempel
file 662
day

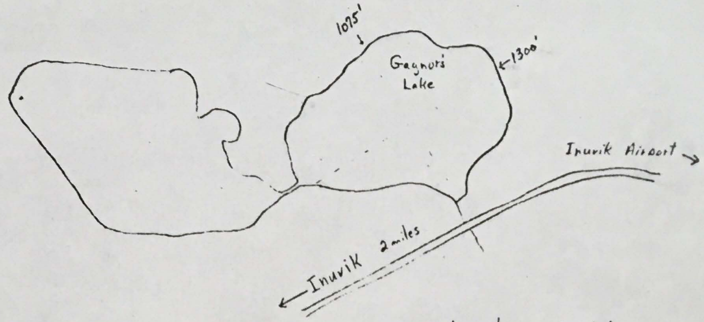


PROPOSED TEST PIPELINE SITE - INUVIK N.W.T.
AIR PHOTO A18646-49 - DIVISION OF MINES & TECH. SURVEYS
SCALE - 1 inch to 1000 ft.

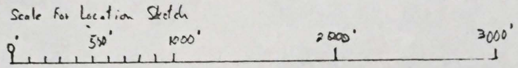
Inuvik Research Centre

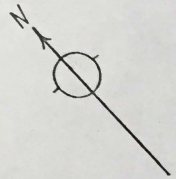
Gaynor's Lake Depth Survey Sketch of shoreline and 5' bottom contours

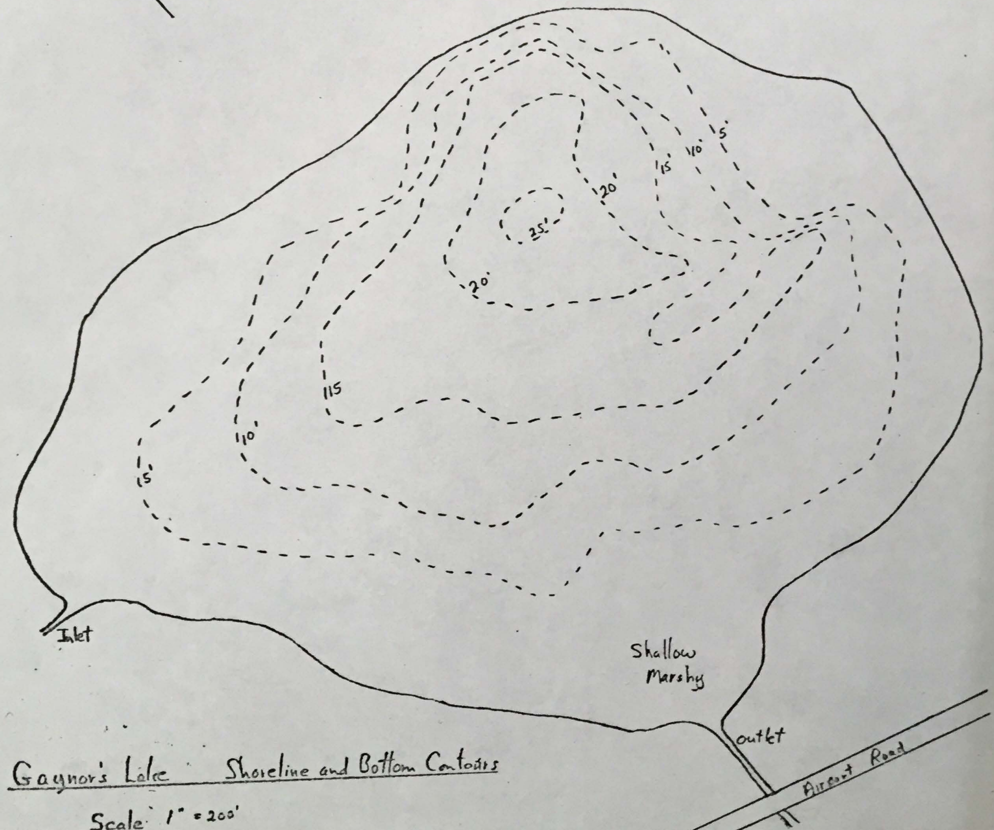
Carried out October 28, 1965 Greatest depth 26'
By R. Hunter and N. Dick
Drawn by R. Hill



Location Sketch







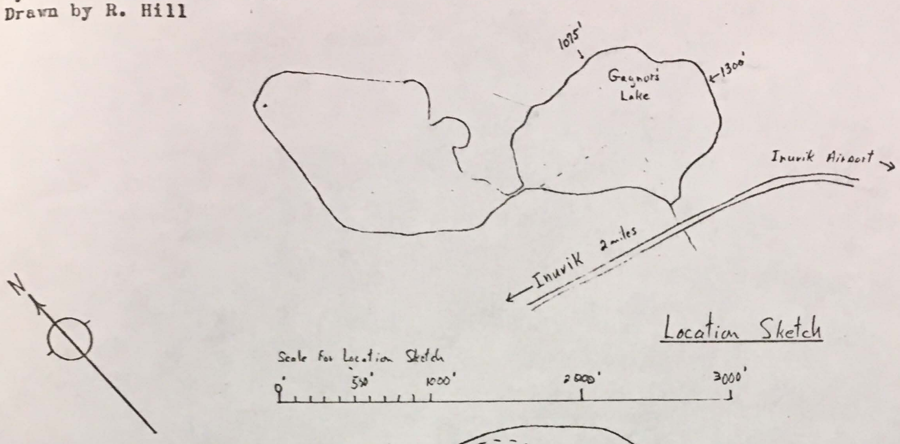
Gaynor's Lake Shoreline and Bottom Contours

Scale 1" = 200'

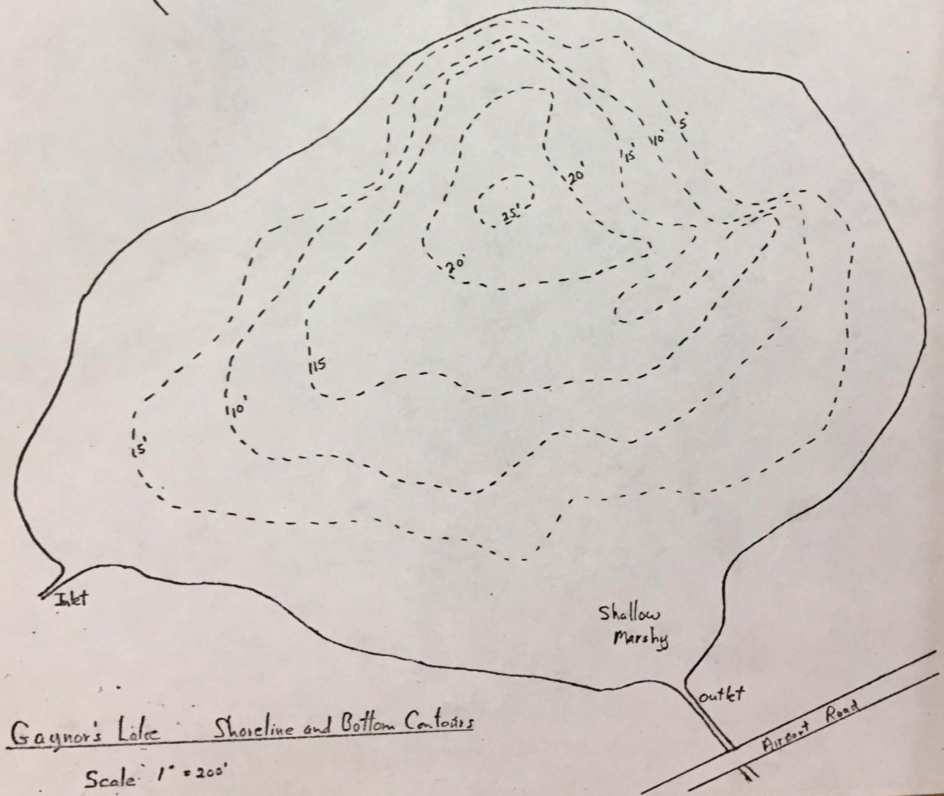
Inuvik Research Centre

Gaynor's Lake Depth Survey Sketch of shoreline and 5' bottom contours

Carried out October 28, 1965 Greatest depth 26'
By R. Hunter and N. Dick
Drawn by R. Hill



Location Sketch



Gaynor's Lake Shoreline and Bottom Contours

Scale 1" = 200'

April 12, 1967

Mr. K. R. Shipley
Imperial Oil Limited
Pipe Line Division
111 St. Clair Avenue, West
Toronto, Ontario, Canada

Attention: Mr. W. J. Keys

Re: 1967 Test Program - Project #483

Dear Sir:

Thanks for your letter of March 23 and the minutes of the March 22 meeting which reviewed proposed work under Project #483. You and Mr. Hemstock have done a fine job of reviewing the Arctic research work and programming the future test work.

We are in agreement with Bob Bullock's recommendations given in his letter of April 4, on training of the installation engineer in strain gauge techniques. With all the effort which will be expended, we would not want to fail because of sub-standard equipment or installation.

We will be interested in hearing of your future planning.

Yours very truly,

L. B. Morrow

LBM:ms

cc: Mr. R. L. Bullock

P/L DIVISION
FILE No. 9.666E
APR 14 1967

	NOTE	ACT	INITIAL
KRS	✓		
CC	✓		
OMK			
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BMB			
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CVH			
WJK	✓		

DATE ANS'D 7/24

April 10, 1967

<u>Re: Project #483, Arctic Pipeline Research</u>

File: 9,666E

Mr. L.B. Morrow
Standard Oil Company (N.J.)
Pipe Line Research
30 Rockefeller Plaza
New York City, N.Y. 10020

Dear Sir:

The proposal to use a Program of mathematical stress analysis to determine the stress on pipe laid in permafrost terrain has been considered from a number of standpoints. We have reviewed this approach and feel that it cannot be applied effectively since the "input data" is not known.

Therefore, the proposed test program is perhaps best thought of as an experiment which will be set up to obtain data rather than as a finite step in this area of research. The attached review briefly covers our analysis of the mathematical approach.

Yours very truly,

K.R. Shipley

By:________________________
W. John Keys.

WJK/EG.

cc. Messrs. R.L. Bullock, Humble, Houston.
R.A. Hemstock, Calgary.
E.W. Christian, Edmonton.

MATHEMATICAL STRESS ANALYSIS

ARCTIC PIPE LINE RESEARCH

PROJECT #483

A review has been made of the method of applying a mathematical method of analysis to determine stresses that may be encountered in a pipeline in the Arctic. Two Pipe Line Research reports have been used as a reference in looking at this approach. They are PLR-F-96-66 "Analysis of Pipeline Laying Procedure by Computer Program" and PLR-F-97-66 "Pipeline Analysis for Shipping, Laying and Backfill Loads".

Regarding F-96, the pattern of deflection, the loads and forces, heights, etc. are known or can be reasonably, accurately predicted. Test programs run on lines such as the Interprovincial Pipe Line 34" laying job have provided some actual field test data which can be used, or at least is valuable, as a reference to check the validity of any calculations. The program provides for those only "normally encountered" forces such as may be incurred in reasonably straightforward, flat terrain. This latter is not a criticism, rather a comment since it is realized that it would be almost impossible to predict the abnormal forces either in direction or extent that occur in laying a line in rugged terrain such as that frequently encountered in mountains, valleys, rock, muskeg, etc.

Regarding F-97, the section on shipping is a separate matter concerning all pipe lines and the section on installation covers much of the same work as F-96. The part of the report dealing with overburden loads again deals with forces and loads that are reasonably determinate from formulae, field tests or empirical data, although even here, as the report states, there are significant inconsistencies in predicting the load. This report provides useful data as well as convenient references for further data if desired, on soil loads, time lag for compaction, soil resistances and bedding factors and it very effectively points out the importance of considering backfill as a source creating stresses on buried pipe.

The proposed test program on an Arctic pipe line is aimed at obtaining some field test data on the forces and loads and, to some extent, the resulting stresses that may be imposed on a pipe line installed in the permafrost terrain in the Arctic.

In summary, it is believed that such a pipe line will be subjected to unusual forces and loads due to the abnormal conditions of terrain and climate and due to the associated problems of laying such a line. Existing information or literature provides little data in this regard so it is hoped the test will tell us <u>if</u> what we believe is true, <u>how</u> and <u>why</u> these forces occur as they do and <u>what</u> the extent and nature of these are. Because we are presently lacking this fundamental data, assuming that there are, in fact, forces of unusual extent and nature, we cannot effectively use a mathematical method of analysis to determine stresses that occur in a line. In effect then, the test program is intended to provide the input data for such an analysis.

W. John Keys.

WJK/EG

April 6, 1967.

April 12, 1967

Pipe Line Stresses
Arctic Pipe Line Research
File: 9.666E

Mr. R. H. Teskey
Imperial Oil Limited
Western Region, Producing Dept.
339 - 50th Avenue S.E.
Calgary, Alberta

Attention: Mr. R. A. Hemstock

Dear Sir:

We have not yet replied to Mr. R. L. Bullock's letter of April 4, 1967 concerning their participation in the stress analysis techniques. Since you will be in the Arctic this week and we will be discussing the proposed test site on your return, we can review your thoughts on this matter also at that time.

In particular we want to get your feeling on the following points: the technical status of your staff at present on this subject, your opinion of Mr. Bullock's recommendations, any plans you may have made along the lines of these recommendations, the extent of help that we may provide and also the assistance that we may ask Humble to give.

We will look forward to reviewing plans with you by telephone next week.

Yours very truly,

K. R. SHIPLEY

By: ________________
W. J. Keys

WJK/sr

HUMBLE PIPE LINE COMPANY
P. O. BOX 2220
HOUSTON, TEXAS 77001

April 4, 1967

TECHNICAL SERVICES DEPARTMENT
GEORGE G. HUGHES, JR.
MANAGER
A.V. CARDIN
ENGINEERING COORDINATOR
J. E. BARBEE
COMMUNICATIONS COORDINATOR
ROBERT L. BULLOCK
RESEARCH COORDINATOR

P/L DIVISION
FILE No. 9.666E
APR 7 1967

	NOTE	ACT	INITIAL
KRS	✓		KRS
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CVH			
WJK	✓		WJK

DATE ANS'D 669

Re: PLR #482, Arctic Project

wrote RAH on Apr. 12/67

Mr. K. R. Shipley
Imperial Oil Limited
Transportation and Supply Department
111 St. Clair Avenue West
Toronto, Canada

Attention: Mr. W. J. Keys

Dear Mr. Shipley:

Thanks for keeping us abreast of your progress on the Arctic Project PLR #483. The minutes of the March 22, 1967 meeting are very informative and indicate that you and Alex Hemstock are concentrating on the planning of future tests.

The proposed pipelines stress tests in permafrost areas scheduled for 1967 appear to be adequate to experience and measure the stresses anticipated. The point on Humble Pipe Line's help in the installing of strain gauges, however, is perhaps not defined. Mr. B. W. Walton, who has been acting as the strain gauge consultant, does not believe he is qualified to install the gauges. It has been ten years since Mr. Walton attended the school on strain gauges and it is his opinion that his training is not adequate for present day materials, instrumentation and installation techniques.

Since the tests are a one time project, we agree with Mr. Walton and recommend that every effort be made to obtain the most up-to-date information on instrumentation, type gauges and installation techniques. We therefore recommend that Imperial's installation engineer do the following as soon as possible:

1. Attend a strain gauge school.

2. Visit a manufacturer of gauges to review latest equipment, etc.

3. Visit with some research consulting group such as Battelle Memorial Institute to discuss overall proposal.

If we can assist in carrying out this recommendation, please advise.

Yours very truly,

Robert L. Bullock

RLB:mac

cc: Mr. R. A. Hemstock
Mr. H. C. Cook

March 23, 1967

Re: 1967 Test Program - Project #483

File: 9.666E

Mr. H.C. Cook
Standard Oil Company (N.J.)
30 Rockefeller Plaza
New York City, N.Y. 10020.

Dear Sir:

We have attached a copy of the minutes of a meeting held here on March 22 regarding plans for the test installation on pipe line stresses as discussed at the Calgary meeting last fall. We took advantage of this opportunity for a couple of hours while Mr. Hemstock could be here.

By copy of this letter and minutes to Mr. R.L. Bullock we solicit any suggestions or comments you or he may wish to make. There was brief discussion on the possibility of a further meeting after the site has been selected and the layout prepared, to cover plans in more detail. You and Mr. Bullock may wish to participate in such a meeting although no definite plans re. time, location or participation were made.

Again, we welcome all comments on this matter.

Yours very truly,

K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.

cc. Messrs. R.L. Bullock, Houston
R.A. Hemstock, Calgary
E.W. Christian, Edmonton
B.G. McKenzie, Edmonton (blind)

PIPE LINE STRESSES - 1967 TEST PROGRAM
PROJECT #483

A brief meeting was held in Mr. C. Carlisle's office, Pipe Line Division, on March 22, 1967, when Mr. A. Hemstock was passing through Toronto on his way to a meeting in Ottawa. The purpose was to review some aspects of the overall Arctic research and, in particular, the proposed 1967 test program. In attendance were Messrs. K.R. Shipley, R.A. Hemstock, C. Carlisle and W.J. Keys.

The attached "agenda" dated March 21 and sketch of proposed test program was passed out and each of the points reviewed.

Mr. Hemstock advised that, although much of the stress and emphasis has been on the Rainbow Lake-Zama Lake area, they (Producing Dept.) have a significant committment in the Arctic area and therefore will continue their activity even if it reduced level in the immediate future. Future slackening of activity in areas such as Rainbow will probably cause renewed interest in other areas such as the Arctic. Therefore, there is no change in the eventual plans of exploration or in the timimg which has not been finite anyway.

The area under consideration in so far as Imperial is concerned is essentially unchanged. Exploratory drilling in the delta and Peel Plateau has been carried out and a well is scheduled for the coming winter on an island in the delta-coastal area.

Soil temperature test point installations have proven very satisfactory and records are being maintained. Oil rheology laboratory equipment development is likewise progressing very well. Both these phases will continue in the same manner now being followed.

The matter of offshore pipelines was discussed briefly and it is understood that information from the work being carried out by Humble Production Research will be made available through Pipe Line Research. Imperial Producing have some personnel also participating in this production research program on offshore techniques. Arctic offshore will be a special case, likely utilizing the knowledge of both pipeline and production research projects.

There was some discussion on the visit made to Canada by Russian "oilmen" in late 1966 since Mr. Hemstock was involved in escorting these people about. In general, it appears that there are few, if any, very new or different techniques practised by these people although they have extensive far north operations. However, as in the past, we must keep abreast of their work in production and pipelining in every possible way.

Regarding the test program, it was generally agreed that, although the emphasis is not as imminent, it is advisable to proceed now because:

(a) it will take a year, at least, for conditions to stabilize in order to get significant results from installation
(b) it is desirable to have "lead time" so that negative results, obviously ineffective test procedures or results that show clearly there is a need for further testing in a critical area, can then be taken care of in a proper and timely fashion
(c) it is not felt that we can duplicate, in a laboratory or other field test, the conditions to be encountered in this area. Nowhere in southern climes do we have or can we adequately create, the permafrost condition of a frozen impervious barrier overlain with a thin active "skin" subjected to the variations of weather, seasonal changes in or on which a pipeline is laid

(d) a great part of the value of the test installation will be in the techniques and special problems encountered during and after laying a line in this terrain
(e) additional soil temperature data will be obtained since it is proposed to put in thermistors at the time the installation is made to gather data on excavation re-freeze and line temperature
(f) even if there is no requirement for construction of a line for several years, this test will serve to have shown up "do's and don'ts", improve our economic assessment of future projects, enable much better evaluation of new ideas as they come along and, if shown to be necessary, concentrate on certain areas where development work is required.

Once the installation is made and checked out, Mr. Hemstock advised that he is quite sure that the National Research Council of Canada personnel at Inuvik will be very agreeable to make test checks and record data for us on a "classified" information basis.

At the meeting held in Calgary last year, around November, it was thought that the test installation would be made in early winter 1967 to simulate, to some degree, winter construction. However, at this meeting it was generally agreed that late August or early September would be the best time to make this installation because of extensive instrumentation, limited availability of equipment etc. Regarding equipment to lay such a line, Mr. Hemstock advised that they have a couple of "Cats" and other equipment that will be moved from the present drilling site for later movement to the proposed site on the island at the delta and these could likely be moved to Inuvik and left there - in transit so to speak - to do this installation work.

Mr. Hemstock will check on the official (government) clearance or permission after a site is selected.

Regarding timing of the test program, the following dates are agreed on:
(a) site selection - Mr. Hemstock and, if possible, Mr. J. Keys will visit the Inuvik area during the first or second week of April. At present, the Company aircraft (F-27) makes this trip on Saturdays and Tuesdays; Pacific Western Airlines fly in also about three days a week.

(b) site survey - Mr. Hemstock advises there are good aerial photographs of all this area which should serve (along with any other photos required) for planning and layout purposes

(c) test site layout will be done jointly by Pipe Line Division and Production Research. Following this, estimates will be made, budget (PLR) addition requested and material ordered

(d) Mr. Keys advised that Humble Pipe Line had earlier offered their services in strain gauge installation. The attached sketch gives a very preliminary idea of the type of test set-up proposed. Also, Humble may wish to consider "coating" testing as part of this installation

(e) to meet the installation date of early September or late August, material would have to be in Hay River by July 1st for barge movement up the Mackenzie River. Mr. Hemstock will check on the need to reserve "shipping space".

In summary, the meeting closed with the plans to proceed in 1967 as laid out above unless some change arises in the overall program. Mr. Hemstock planned to review the test program and associated Producing Department plans with his people in Toronto while he was here

W.J. Keys.

WJK/EG
March 23, 1967

PURCHASING DEPARTMENT

MEMORANDUM

P/L DIVISION
FILE No. 9.666E
MAR 27

	NOTE	ACT	INITIAL
KRS			
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OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		JK

DATE ANS'D 5/76.

Attachments retained here. JK.

March 22, 1967

File: 5025-ABT
Ditching In Permafrost

Mr. R. B. Spears,
Building.

Attention: Mr.K.R.Shipley/J.Keys

Barber-Greene Canada Limited state that they have a model TA-77 Ditcher in the possession of Mannix Corporation which is cutting a 54 in. wide trench to a depth of 8 ft. 6 in. on a job near Lesser Slave Lake. It is believed that they have also done some work for Imperial with this machine.

Barber-Greene feel that the equipment might be capable of digging in permafrost and suggest that you discuss the problem with Mr. Wally Kosting, Equipment Superintendent at Westlock, Alberta, phone 267-5111.

O. K. SMITH

Per E. D. Taylor
A. B. Taylor

ABT:MC
4/6

Attach.

9.666E PLR File 483

M[ar]ch 21, 1967

PIPE LINE STRESSES - 1967 TEST PROGRAM

Meeting: The following matters should be reviewed at the meeting on March 22, 1967 regarding the overall Arctic Pipe Line Research Program.

A. Re. Overall Project

1. Any changes in the basic objective. Is there any significant change in Producing Dept. thinking re the Arctic area, either as to eventual exploration and drilling or in the timing of this.

2. What is their present Arctic program? Is the area under consideration still basically the same?

3. Review of the status of the phases they are working on. i.e. soil temperatures and oil rheology.

4. Any particular items that might influence the overall research program.

B. Re. Test Program

1. Any changes in the test program as discussed around November 1st last year.

2. Are we all prepared to proceed assuming a suitable site can be obtained early in April? What official clearance is required in such a test program?

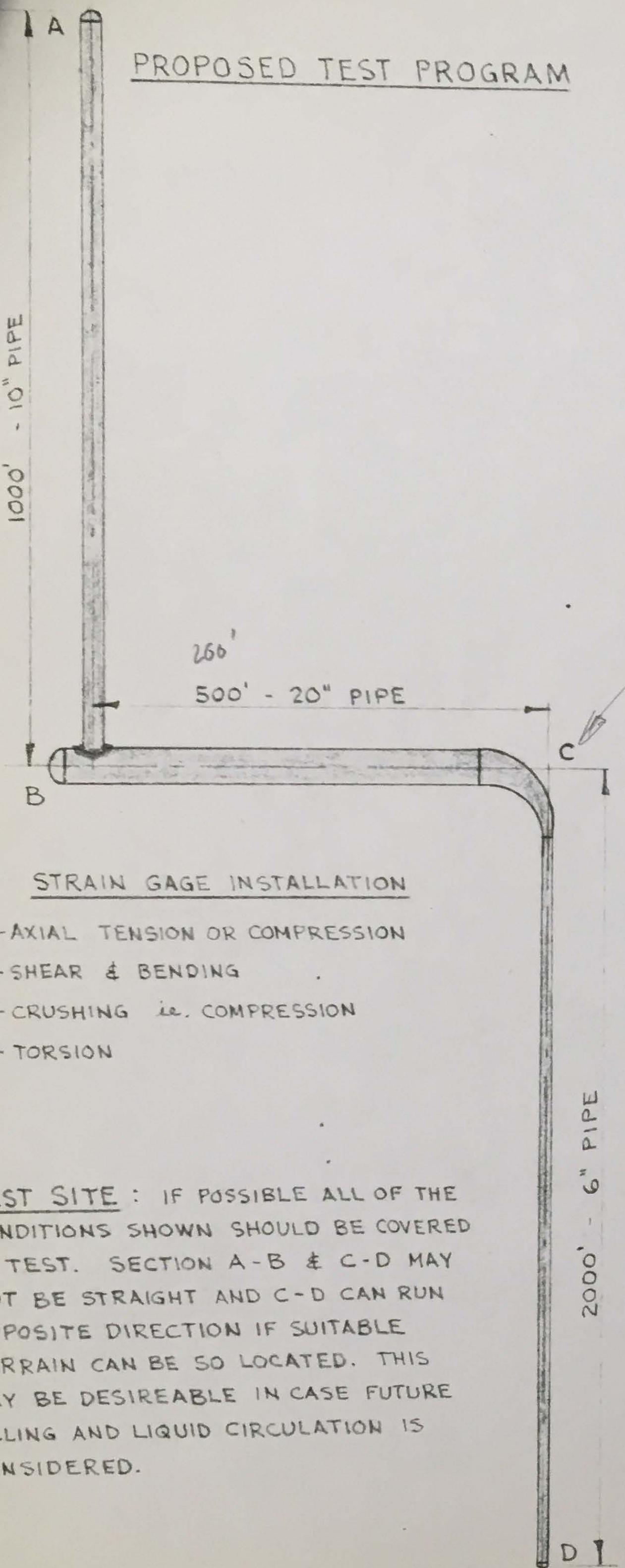
3. Any change in the incentives or need for such a test to be carried out.

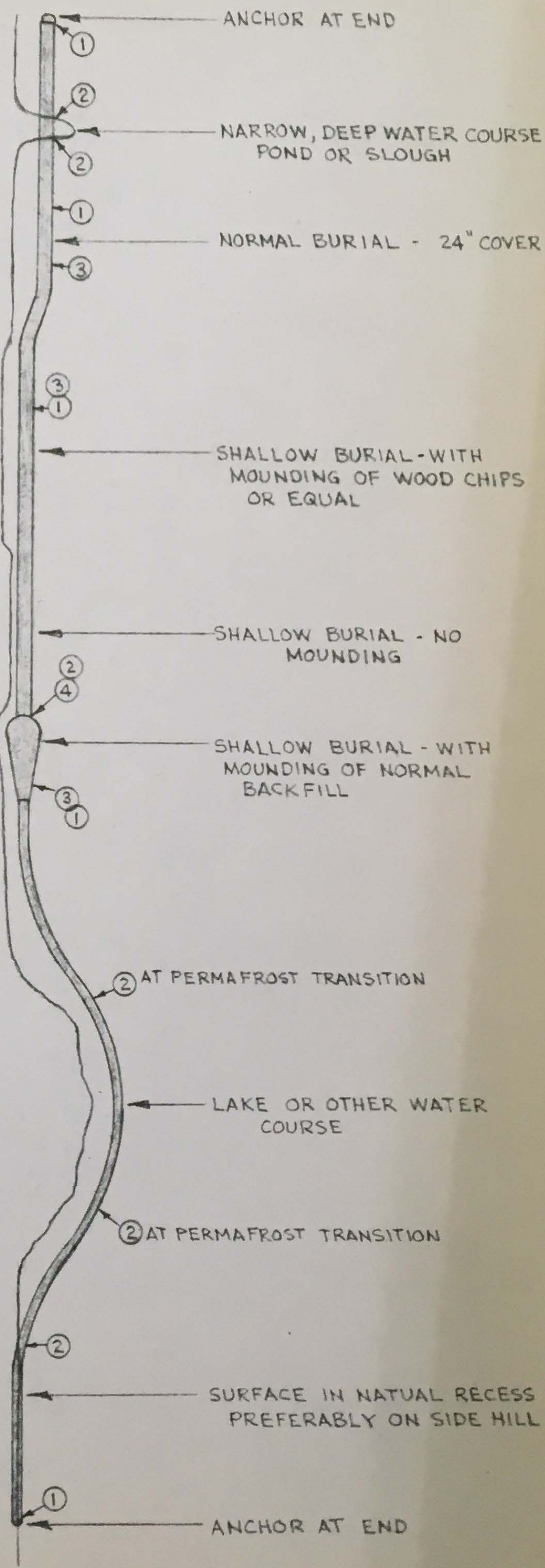
4. Review of timing of the phases of the program. These would include
   - (a) site selection April 15
   - (b) site survey or photograph
   - (c) test site layout
   - (d) material acquisition, transportation and handling June
   - (e) installation Aug.
   - (f) test work.

5. Meeting with PLR.

Test Program - Pipeline Stresses in Permafrost Areas 1967

PROPOSED TEST PROGRAM





STRAIN GAGE INSTALLATION

(1) - AXIAL TENSION OR COMPRESSION
(2) - SHEAR & BENDING
(3) - CRUSHING ie. COMPRESSION
(4) - TORSION

TEST SITE: IF POSSIBLE ALL OF THE CONDITIONS SHOWN SHOULD BE COVERED IN TEST. SECTION A-B & C-D MAY NOT BE STRAIGHT AND C-D CAN RUN OPPOSITE DIRECTION IF SUITABLE TERRAIN CAN BE SO LOCATED. THIS MAY BE DESIREABLE IN CASE FUTURE FILLING AND LIQUID CIRCULATION IS CONSIDERED.

PURCHASING DEPARTMENT

MEMORANDUM

March 16, 1967

File: 5025-ABT
Ditching In Permafrost

Mr. R. B. Spears,
B u i l d i n g .

Attention: Mr.K.R.Shipley/J.Keys

The Bucyrus Erie Company of Canada Limited have replied to our enquiry as shown above and have stated that while they have no equipment that would perform this service for us they suggest that you approach the Canadian Pipeline Contractors Association at 307 Revillon Building, Edmonton, Alberta.

They suggest that the members of this association have installed pipelines in all parts of the world and that threre might be some experienced people available for information on ditching in very cold climates.

Please let us know if you wish to make this contact or if you would like us to.

O. K. SMITH

Per A B Taylor
A. B. Taylor

ABT:MC
3/31

Attach.

P/L DIVISION
FILE No. 9.666E
MAR 17 1967

	NOTE	ACT	INITIAL
KRS			
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RDC			
CVH			
WJK	✓		

DATE ANS'D 5.21

Attachments retained in Project #481 file

Aircalute — C C Cl

KRS KRS

ORTATION AND SUPPLY DEPARTMENT
PIPE LINE DIVISION

14, 1967

967 Test Program - Arctic Pipe Line Research

File: 9.666E

TO FILE:

Further to Mr. A. Hemstock's letter of March 6 concerning a proposed trip to Inuvik, this was discussed with him by telephone on March 10. It now appears likely that this will be during the first week of April.

The I.O.L. F-27 'plane makes the trip on Tuesdays and Saturdays. PWA also fly in about three days a week so that if one wished to stay for less than three days, this service is available.

Mr. Hemstock is attending a meeting in Ottawa on March 23 and could visit here on his way down if necessary but would prefer to come to Toronto about two weeks after the proposed trip to review the test programme with us and also Mr. H. Cook if he wished to attend. This would still allow time to get material ordered and shipped and installation made this year. Further delay beyond that date would make it rather difficult to meet shipping schedules.

We have to advise him this week regarding his visit.

W. John Keys.

W. John Keys

WJK/EG.

A. H. will be in PLD.
Toront Wed. Mar 22 @ 9:00 pm
C.C.

FROM DATE

MEMORANDUM

TRANSPORTATION AND SUPPLY DEPARTMENT
PIPE LINE DIVISION

March 14, 1967

Re: 1967 Test Program - Arctic Pipe Line Research

File: 9.666E

TO FILE:

Further to Mr. A. Hemstock's letter of March 6 concerning a proposed trip to Inuvik, this was discussed with him by telephone on March 10. It now appears likely that this will be during the first week of April.

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W. John Keys.

W. John Keys

WJK/EG.

A. H. will be in PLD.
Toront Wed. Mar 22 @ 9:00 pm
C.C.

PURCHASING DEPARTMENT

MEMORANDUM

February 21, 1967

File: 5025-ABT
Ditching In Permafrost
Your: 9.666E

Mr. R. B. Spears,
Building.

Attention: Mr.K.R.Shipley/W.J.Keys

The first response to our enquiry for equipment suitable for ditching of permafrost is the enclosed letter of February 17 from J. I. Case Company.

We are attaching literature on their heavy duty backhoe equipment and if you feel that any of this is of sufficient interest to warrant further investigation please let us know.

O. K. SMITH

Per J. G. Gibbs
J. G. Gibbs

JGG:MC
3/8

Attach.

P/L DIVISION
FILE No. 9.666E
FEB 22 1967

	NOTE	ACT	INITIAL
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CVH			
WJK	✓		JWK

DATE ANS'D 3/7.

J. I. CASE COMPANY
MANUFACTURERS OF AGRICULTURAL AND INDUSTRIAL EQUIPMENT

ISLINGTON, ONTARIO
17 VICKERS ROAD
PHONE: 239-2731

February 17, 1967

Imperial Oil Limited
111 St. Clair Avenue West
Toronto, Ontario

Attention: Mr. O. K. Smith

Gentlemen:

Subject: File: 5025-ABT
Ditching in Permafrost

We have very carefully studied your letter dated February 15th on the above subject, and with total lack of experience operating our equipment under these conditions, it would be impossible for us to recommend equipment that would do the job you have to do in the north.

We are enclosing with this letter, literature on our heavy-duty backhoe equipment for your consideration. We have seen these machines operate in extremely hard soil quite successfully, but we cannot visualize what a problem it would be to cut through ground that is frozen solid. If this frozen soil has a gravel texture, or it is sandy enough to break up easily, our equipment might do this job for you. If it is frozen to the consistency of ice or concrete, then of course, our equipment would be unable to penetrate.

If you require any further information on Case machines, we will be glad to provide it. In the meantime, we thank you for your interest.

Yours truly,

C. J. LaValley

C. J. LaValley
Toronto Branch Sales

CJL:ks
cc: W.F.G. Randall

March 10, 1967

File: 9.666E
Your File: 5025-ABT.

<u>Re: Permafrost Ditching</u>

Mr. A.B. Taylor,
Room 511
Purchasing Dept.
Building

We wish to thank you for your letter of February 28, 1967 and attached letter from Buckeye Division of Gar Wood Industries Inc. As mentioned in our conversation,we will follow this up through Esso Research, however, we will wait for a while in case some definite avenue is opened up via the route set forth in Mr. Crabiel 's letter. Our contact with CRREL has been very general and only via letter, so it is very possible that some direct personal contact may evolve through this correspondence.

It does not appear very likely that their model 318 trencher is markedly different from other similar machines though it is understood that it is one of the best, however, should they have one operating under extreme conditions in a reasonably immediate area, we would be agreeable to meet with them.

We shall await your reply to their contact of CRREL before taking any further action along this line.

K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.

IMPERIAL OIL LIMITED

PRODUCTION RESEARCH & TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT

R. H. TESKEY,
MANAGER

339-50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

March 6, 1967

Mr. K. R. Shipley
Manager
Transportation and Supply Dept.
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W.J. Keys

Dear Sir:

Gerry Rempel and I are presently planning a trip to Inuvik, either the last week of March or the first week of April.

This would probably be a good time to select sites for the pipeline testing that we discussed in 1966.

Would you let us know if you would like to make this trip, and if so, what time is most suitable to you. We would expect to be in Inuvik at least three days.

Yours very truly

R. H. TESKEY

By R A Hemstock
R. A. Hemstock

RAH/mt

file 662
day

called Alan Mar 10/67
see memo to File of Mar 13

P/L DIVISION
FILE No. 9.666E
MAR 7 1967

	NOTE	ACT	INITIAL
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CC	✓		cc
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CVH			
WJK	✓		[illegible]

DATE ANS'D 4.5.3

March 3, 1967

Re: Arctic Research Test Program

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
Western Region Producing Dept.
339 50th Avenue S.E.
Calgary, Alberta.

Attention Mr. R.A. Hemstock

Dear Sir:

We have attached hereto, a number of bulletins and pamphlets on strain gauges, their use and application. This was forwarded to us by Humble, as promised, as you will note from their covering letter. They did not indicate if they wanted any of this material back but it may be best to keep it all together in event they do. It is hoped this may be of some help to Mr. G. Mainlander in his test work planning.

At the meeting held in your office last fall it was tentatively agreed that we would look at a further meeting to discuss, or at least plan to review in some manner, our test plans for 1967, sometime in the latter part of March. Due to other work we have had only a limited opportunity to delve into the 1967 test program beyond the extent covered at that meeting.

We will call you within the next week to go over what your group has done, to discuss a plan or program and to initiate any required action or set up a meeting as may seem expedient.

Yours very truly,

K.R. Shipley,

By:________________________
W. John Keys.

WJK/EG
Encls.

March 3, 1967

<u>Re: Report on Ice Engineering</u>

File: 9.666E

Mr. R.H. Teskey
Impwrial Oil Limited
Western Region Producing Dept.
339 50th Avenue S.E.
Calgary, Alberta.

<u>Attention Mr. R.A. Hemstock</u>

Dear Sir:

We wish to thank you for your report IPRT-IME-67 entitled "Ice Engineering Pertinent to the Oil Industry". This is an excellent guide and also stimulates considerable thought for future research, particularly with regard to Arctic offshore work.

In case you have not yet already done so we would like to suggest that you send a couple of copies to Mr. Harry Cook since it bears close relation to possible future research work.

Yours very truly,

K.R. Shipley,

By:________________________
W. John Keys.

WJK/EG

PURCHASING DEPARTMENT

MEMORANDUM

February 28, 1967

File: 5025-ABT
Ditching In Permafrost

Mr. R. B. Spears,
B u i l d i n g .

Attention: Mr.K.R.Shipley/W.J.Keys

As discussed with you by telephone on February 27 we attach two copies of Buckeye quotation of February 24 whereby they make reference to the Cold Regions Research and Engineering Laboratory located in Hanover, New Hampshire and operated by the U. S. government military facilities.

We understand that you will be developing this phase with Esso Research.

O. K. SMITH

Per A. B. Taylor

ABT:MC
3/15

Attach.

P/L DIVISION
FILE No. 9-666E -?
MAR 1 1967

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WJK	✓		WJK

DATE ANS'D 4/20

Attachments kept on file here in Project #483 File

AREA CODE 419
422-9121

Buckeye DIVISION

GAR WOOD INDUSTRIES, INC.

FINDLAY, OHIO 45840

February 24, 1967

Imperial Oil Limited
111 St. Clair Ave., West
Toronto, Canada

Attention: Mr. O. K. Smith
Purchasing Agent - Central Division

Subject: File 5025 ABT
Ditching In Permafrost

Gentlemen:

We wish to acknowledge and thank you for your February 15 letter regarding Ditching In Permafrost.

While we have not had specific experience in the trenching of Permafrost, we have had considerable experience trenching various rock formations, hard coral, decomposed granite and other cemented materials and through the years have developed cutting equipment and cutting equipment patterns that have greatly improved the productive capacity of our machines in these materials.
2 Just how these hard materials compare to Permafrost, we do not know. We do know that if any ditching machine has been able to satisfactorily cut Permafrost, that we can assure maximum production by the use of BUCKEYE Ditchers.

As we are in frequent contact with U. S. Government Military facilities, we took the liberty of contacting Mr. Arthur J. Rutherford, Chief of Mechanical Equipment Laboratories, Engineering Research and Development Laboratories, Fort Bellvoir, Virginia, knowing that this gentleman, several years ago, had experience in excavating and drilling in Permafrost. Mr. Rutherford advised that approximately seven or eight years ago the U. S. Army Corp of Engineers established the Cold Regions

Research and Engineering Laboratory, located in Hanover, New Hampshire, for the prime purpose of developing mechanical devices and methods for excavating Permafrost. Foster Miller and Associates of Boston, Massachusetts, as we understand it, do a considerable amount of the technical research and analysis for the Corp of Engineers in this respect.

Just what they have developed or observed in this region is unknown to us at this time, however, we are requesting from them whatever information is available. We are certain that it will be permissable for Imperial Oil Limited to directly request similar information from them if you so desire. Although, we have no historical background related to excavation of Permafrost, we do feel that our Model 318 Pipe Line Ditcher would adequately meet the ditch size requirements and that by proper selection of cutting equipment and its pattern, that the possibilities of satisfactory excavation are not entirely remote.

Perhaps after we obtain information from the Cold Regions Research and Engineering Laboratories, we will be better able to evaluate possible productive capacity of the ditcher, will advise you further on this.

The continuous method of excavation created by a wheel type ditcher is the most efficient and practical method known to date and we feel that if any piece of equipment can excavate this material, it will be the BUCKEYE Wheel Type Ditcher.

Another aspect which we feel is worthy of your consideration, would be to have us locate one of our wheel type ditchers, preferably the Model 318, working in rock conditions with the thought in mind of meeting your engineers or operating personnel at the machine site for observation, analysis, and discussion.

We wish to assure that we will cooperate to the fullest extent in an attempt to help you with your requirements. We shall look forward to hearing from you regarding this communication.

Buckeye

Enclosed for your reference are brochures covering the BUCKEYE Models 318 and Super "7" Ditchers as well as a pamphlet on Pipe Line and Distribution Ditchers.

Very truly yours,

W. I. Crabiel

W. I. Crabiel

WIC:mw

cc: T. W. Schultz
W. H. Garrison

HUMBLE PIPE LINE COMPANY
P. O. Box 2220
HOUSTON, TEXAS 77001

January 17, 1967

TECHNICAL SERVICES DEPARTMENT
GEORGE G. HUGHES, JR.
MANAGER
A.V. CARDIN
ENGINEERING COORDINATOR
J. E. BARBEE
COMMUNICATIONS COORDINATOR
ROBERT L. BULLOCK
RESEARCH COORDINATOR

7.8.3 Arctic Pipeline Study
Project 482

Mr. K. R. Shipley
Imperial Oil Limited
111 St Clair Avenue West
Toronto, Ontario
Canada

Attention: Mr. W. J. Keys

Dear Mr. Shipley:

The projected work by Humble Pipe Line on the Arctic Study for 1967 appears to be rather limited. An investigation into the best means of providing cathodic protection where required in the Arctic region is planned. Continued assistance and advice on strain gauge measurement on the pipe stress phase of the project is awaiting your request.

No further work on cold weather welding is anticipated. However, comments from your people observing the progress on the Rainbow expansion work would be appreciated, particularly along the lines of welding and coating experience.

In reviewing the minutes of the Arctic Study meeting held in Calgary last October, it appears that you have an ambitious program scheduled for 1967. Since our work, this year, is limited to corrosion and welding, we invite you to call on us if we can be of any assistance in other areas.

Yours very truly,

Robt L Bullock

Robert L. Bullock

9.666E

RLB:FAT:mac

cc: Mr. H. C Cook
Central Records

✓
✓

✓ WJK
108.

Answered Feb 14/67

February 17, 1967

Re: Muskeg Handbook

File: 9.666E

Mr. R.A. Hemstock
Imperial Oil Limited
Western Region Producing Dept.
339 50th Avenue S.E.
Calgary, Alberta.

Dear Sir:

Please excuse the delay in replying to your letter of February 2, 1967 re. the article for the forthcoming muskeg handbook. This draft, with illustrations, looks very good.

Please show the title of Senior Design Engineer on Page five of the article. If we can give further assistance please do not hesitate to advise.

Yours very truly,

K.R. Shipley

By:____________________
W. John Keys.

WJK/EG.

February 14, 1967

Re: Arctic Pipeline Study - Projects #482 and #483

File: 9.666E
Your File: 7.8.3

Mr. R.L. Bullock
Humble Pipe Line Company
P.O. Box 2220
Houston, Texas 77001

Dear Sir:

We wish to thank you for your letter of January 17, 1967 outlining your proposal work on the above Project and your willingness to provide further assistance in other areas that require investigation.

One phase where we may wish to obtain your help is in the investigation of ditching equipment for use in permafrost. This will now involve, as we now envisage it, developmental discussions with manufacturers and suppliers on what problems thay might anticipate, any "ideas" they may have, test work they may have undertaken in this area or research they may plan or be willing to do along these lines.

We have initiated some action through the Purchasing Department of Imperial Oil Limited whereby enquiries will be made along the lines set forth above. Since virtually all of the manufacturers of this type of equipment are in the United States it may be more convenient and expedient for you to follow up some of this work for us, or at least along with us. We will have more information on the outcome of these enquiries soon and will contact you then with further details.

Our 1967 test programme is not yet finalized, however, we will certainly call on you for assistance in any way possible and will keep you informed on any meetings or plans in this regard.

Mr. R.L. Bullock

February 14, 1967

We have not yet made a trip to witness welding on the Rainbow system but, in so far as is known, the normal cold weather techniques have been followed. It is understood from Mr. Christian's office that the cold weather in this area has been perhaps less severe than usual, enough so, as a matter of fact, to cause the Contractors some concern re. job performance and completion due to their need for freezing of muskeg to support trucks and machines.

Our thanks again for your offer of assistance and we will keep you informed on the activities outlined.

Yours very truly,

K.R. Shipley,

By: ______________________
W. John Keys.

WJK/EG

cc. Messrs. H.C. Cook, New York
R.A. Hemstock, Calgary
E.W. Christian, Edmonton.

February 7, 1967

Re: Pipe Line Research Programme -
Arctic Pipe Line Construction

File: 9.666E

Mr. C.W.E. Miles
Purchasing Department,
Building

The Pipe Line Division of Imperial Oil is co-ordinating a major research project entitled "Arctic Pipe Line Design and Construction". This work is being carried out under the Jersey Pipe Line Research Programme. Due to many phases that must be investigated in this particular project, the Imperial Production Research Laboratory, Calgary and Humble Pipe Line Co., Houston are conducting investigation work on certain sectors along with us.

As a matter of interest to give you some of the background, we are developing information on terrain, climate, material supply and transportation, energy sources and utilization, design of line and stations, corrosion, construction of lines and stations, etc. As you will note from the attached report, this ditching is one area where we would like to obtain information and ideas, find out possible plans in this regard or at least plant a seed that may generate research and development in this direction.

We feel that the people most qualified are the suppliers and manufacturers of this equipment, and though our work is confidential to some extent, it is hoped we could approach these people to discuss this matter. After you have had an opportunity to review this we would like to follow through this programme to whatever extent possible at present. We shall await your reply.

K.R. Shipley,

By: ____________________
W. John Keys.

WJK/EG.

Encls.

Ditching in Permafrost

Over the past several years there has been increasing oil and gas exploration activity in the far north of Canada and Alaska. The Cook Inlet section of Alaska has already become a substantial oil producing area and extension of the Rainbow Lake (Alberta) area northward as well as substantial gas discoveries in Northeastern B.C. indicates the vast potential of this far north country as a petroleum source.

It is a widely held belief in industry and government that major petroleum discoveries in the North American Arctic and sub-Arctic are likely in the next few years. Transporting this oil and gas overland to market areas can only be done economically by pipelines. In recent years improved technology, equipment and ingenuity have not only made northern winter pipelining possible but have shown it to be the "best answer" to operating in muskeg and in the new developing areas where no roads, or at best only temporary trails, exist.

As we move further north these cold weather techniques will, no doubt, prove adequate and, except for lengthened supply lines, accomodation, hours of day-light (winter), etc., the present methods can be adapted. Furthermore, some lines have been built in this region, such as the Canol Line (World War II) and the U.S. Army Alaska Products Pipe Line to Fairbanks (1954), however, the cost was very high such as only defense projects could normally support.

There is one unique characteristic of the Arctic and sub-Arctic (just below the Arctic Circle) and that is permafrost. This is not encountered in the northerly area of the Western provinces and in the mountainous (rock) regions it is of little concern although it may exist. Permafrost is by simple definition "Permanently frozen ground" and refers to the thermal condition of earth materials under which their temperature remains below 32ºF continuously. On this basis, whether sand, gravel, silt, peat, refuse, bedrock, etc. that remains below freezing is called "permafrost".

The cross section of permafrost areas can be classified into the active and the frozen layers which, respectively, exhibit the following characteristics:

a) Active layer: Above the upper surface of the permafrost there is a layer of soil or rock called the active layer which freezes in winter and thaws in summer. Depending on the area and the region (climate) its thickness may vary from a few inches (in the far north) to several feet. Also, local variations occur due to insulating quality of growth (if any), soil cover (vegetation) and soil composition.

b) Permafrost: This perennially frozen ground may vary from a few feet in sub-Arctic regions to several hundred feet in the more northerly area.

The features of interest for the purpose here are the characteristics of the permafrost. This perennially frozen ground may contain a great deal of ice. The ice segregation will range from a coating or films on soil particles and tiny ice lenses to large inclusions up to several feet thick and all forms of segregation may occur in the same material. Ice content of fine grained materials (soil) may be very high yet difficult to discern. Permafrost is normally literally "hard as a rock" but its strength is dependent on its composition, soil texture, ice content and temperature. Its hardness and high strength can be largely attributed to the cementing action of the ice which binds the soil particles into a solid mass.

The mechanical properties of such frozen ground in which ice fills all or nearly all of the interstitial space between soil grains, tends to approach that of ice. The strength and hardness of frozen ground increases with decrease in temperature and in general with increase in moisture (ice) content.

Much of the Arctic, except for the rocky, mountainous areas, is covered with fine grained soils such as silts, clays and fine sands or combinations of these. Most of these soils are covered with organic materials which form the insulating "active" layer and the soils usually contain large quantities of ice and are perennually frozen. Thus we have the typical permafrost terrain.

Laying pipelines in this terrain will doubtless present a number of problems and require new techniques being applied. Of particular concern here and of major importance, is the ditching. The points and questions raised relative to this are as follows:

1. Can the basic wheel type trenching/ditching machine be used in this type of soil? Line sizes would probably be in the big inch class, say 20" and up whether oil or gas.

2. What changes or modifications re. teeth, superstructure, drive, spoil belts, tracks, etc. would be necessary in so fas as one can anticipate?

3. Is a different approach (machine-wise) necessary, that is to say, in the overall machine or in substantial portions of its design?

4. Can we estimate the speed of operation (line progress) that would be attained? Is down-time likely to become a major factor because of the severity of service?

5. Is there any possible pre-trenching work on the ditch line (such as ripping, blasting, etc.) that would be effective yet economical? Is two-pass trenching worth consideration and would it provide any advantage? Are frost-cutting wheels of probable value in pre-trenching work?

6. If trenchers, even in modified form, cannot be utilized effectively, what alternatives can be proposed? It would appear that use of backhoes would be equally ineffective, particularly on a "production-type" operation.

As implied above, the modern trencher has been a prime factor in present day pipelining by making possible the rapid, clean, contoured ditching required to keep pace with other operations. It is known that average winter climatic conditions in the Arctic are not vastly different from those already encountered in northern pipeline construction areas to date so that it is expected that lines can be built using presently known though modified, techniques in the Arctic. The one exception is trenching and it is here we wish to take this investigating look.

W. John Keys.

WJK/EG.

IMPERIAL OIL LIMITED

PRODUCTION RESEARCH & TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT

R. H. TESKEY,
MANAGER

339-50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

February 2, 1967

Mr. K. R. Shipley
Manager
Transportation and Supply Dept.
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

Re: Muskeg Handbook

We are enclosing the final draft of the article on pipelines for the forthcoming muskeg handbook.

Thank you for your corrections and additions to the text.

Would you kindly let us know your correct title so that recognition can be properly given in the handbook.

Yours very truly

R. H. TESKEY

By RAHemstock
R. A. Hemstock

9.666E

RAH/mt
encl.

file 131.3
day

Answered
Feb 17/67

✓ 259.

7.4 Pipelines

Overland transportation of oil and gas has necessitated the construction of a network of pipelines in Canada to provide the most economic means of moving large volumes over long distances. These pipelines cross many types of terrain, including muskeg. In fact, in many cases the oilfields are located in muskeg areas so that the gathering of oil and gas has raised difficult engineering problems.

Pipelining, like other types of construction, is preferably performed in warm weather. Where the bulk of the pipeline work is on mineral soil there is usually a definite economic advantage in working in the warm and drier weather of summer and fall. Conventional pipeline equipment and personnel perform most efficiently under these conditions. When muskeg is encountered it is usually possible to "power" your way through it, although this may be very costly and, as experience has shown, not necessarily the most desirable method.

Where muskeg is encountered in patches, where the line is not relatively long or where construction timing dictates, warm weather construction over muskeg can be undertaken. First the right-of-way is cleared through the muskeg areas, usually by hand, though light tracked vehicles with winches are a convenient help. Useable timber is placed beside the ditch centreline as corduroy (Fig. 1). If necessary, additional poles are hauled in to completely corduroy the road area beside the ditch where ditching, stringing and laying equipment must travel. Light tracked vehicles for muskeg are used for emergency and the more difficult supply jobs. Ditching

is done using backhoes or shovels, moving along the "road" and in very wet muskegs the trench sides are sloped very flat to reduce sloughing, also, the extent of ditching "ahead" is held to a minimum for the same reasons. Hauling, stringing, welding, coating and lowering are all done using conventional equipment and techniques as much as possible though modifications, such as load sizes, are made to suit conditions. Almost all pipelines in muskeg are weighted, as for river crossings, to create negative buoyancy, using concrete saddle or bolt-on weights (Fig's 3,4,5). Where the muskeg is underlain with solid mineral soil, hold down clamps with earth anchors may be used to hold the pipe down. (Figure 6).

Particularly where the muskeg occurs in patches, long lengths of pipe may be strung, welded and coated on solid terrain and pulled into place in the ditch which has been made by a backhoe on a "sled" being pulled across the muskeg. Tracked vehicles will place saddle weights on the pipe as required.

Where most of the pipeline - or, at least, extensive sections - are to be built across muskeg and there is some freedom in the timing of the job, it has been found better from both an economic and technical standpoint to work in the winter. The right-of-way is cleared of all brush and debris, preferably in the fall or the early part of winter, though this work may proceed well into the winter. As before, light tracked vehicles are useful in this clearing work though it remains largely a manual operation. After the muskeg has frozen sufficiently a light bulldozer is used to push the snow off the area to be used as a road and pile it over the ditch line. Some placing

of corduroy on the very wet muskegs may be beneficial during this phase of the operation. This "snowploughing" allows the frost to penetrate deep into the road area and is effectively "grading" the right-of-way for equipment movement later, while the snow cover prevents the ditch line from freezing. (Figure 2). As soon as the roadway is capable of supporting the heavy pipeline equipment, construction is started.

The snow is cleared from the ditch line area and conventional trenching machines will easily handle the light frost penetration that has occurred under the snow. Because trenching machines effectively "straddle" the ditch line special precautions may be necessary, such as extra wide tracks, temporary mats for the tracks or lightening (bearing part of weight of trencher) by large side boom tractors which are moving along the road. When a trencher cannot be used the ditch is dug by backhoe moving along the frozen road. The ditch will stand up well and, since all the equipment can work on and from the frozen road, very few problems are encountered. Except for extreme cold and stormy weather, cold weather construction techniques have been developed, such as preheating the pipe for welding, using two welders for each weld pass (in medium and large diameter pipes), keeping weld passes consecutive to minimize cooling in between, controlling post-weld cooling by wrapping pipe with insulating blankets, warming pipe for coating or using yard-coated pipe so that only the joints require coating in the field, etc. For cold weather construction it is desirable to keep the pipe line spread in "tight formation" whereby all operations from stripping snow to clean-up are less spread out. This reduces problems of trench filling with water which freezes,

sloughing of ditch sides, freezing of spoil bank (ditch excavation material) which increases back-fill and clean-up work. Though seasons will vary it has been found that the last half of January, February and March are ideal times for pipelining in muskeg.

Techniques have been developed, particularly in Great Britain, whereby cables and pipelines are ploughed into muskegs or softer soils. A patented plough is used in which the depth of ditch is controlled by the approach angle of the cutting edge of the plough. Two methods are used; one where the cable or small pipe is on a reel which moves on or with the plough, or the pipeline is laid out on solid ground then pulled into the ditch which is opened by the plough in up to half-mile segments by winches. This system has been used on pipe up to 8 inches in diameter and within certain limits and applications, is favorably economic and relatively fast. It has certain disadvantages, such as the coating is frequently damaged unless special additional protection is added, it is suitable for flat terrain since pipe cannot be readily bent to land contours, it does not easily provide for weighting the pipe and, unless extensive use could be made of it on a job, setting up for such an operation may be less desirable than the pulling method referred to in summer construction. Its use for small sizes appears to hold good promise for this application.

Muskeg classification systems or other evaluations can frequently provide valuable assistance in pipeline route selection. The shortest, most direct route is the first choice, regardless of soil or topography due to the cost of the pipe, coating, right-of-way, etc. The larger the pipe diameter the more this straight line

route selection applies, due to the relation of the value of the pipe to other costs. However, deviations from the straight line, due to unfavorable terrain, access during and after construction etc. will often be found desirable both for economic and construction reasons. Here muskeg classification from aerial photographs can be of valuable assistance and is also very useful to the contractor as a guide in pricing the line, predicting trouble spots and planning the work.

The changing technology, improved equipment and techniques and the ingenuity of those responsible for construction have gone a long way in overcoming the forbidding aspects of pipe line work in muskeg and, no doubt, this progress will continue.

R. A. Hemstock, Senior Research Associate - Imperial Oil Limited

W. J. Keys, - Imperial Oil Limited

References

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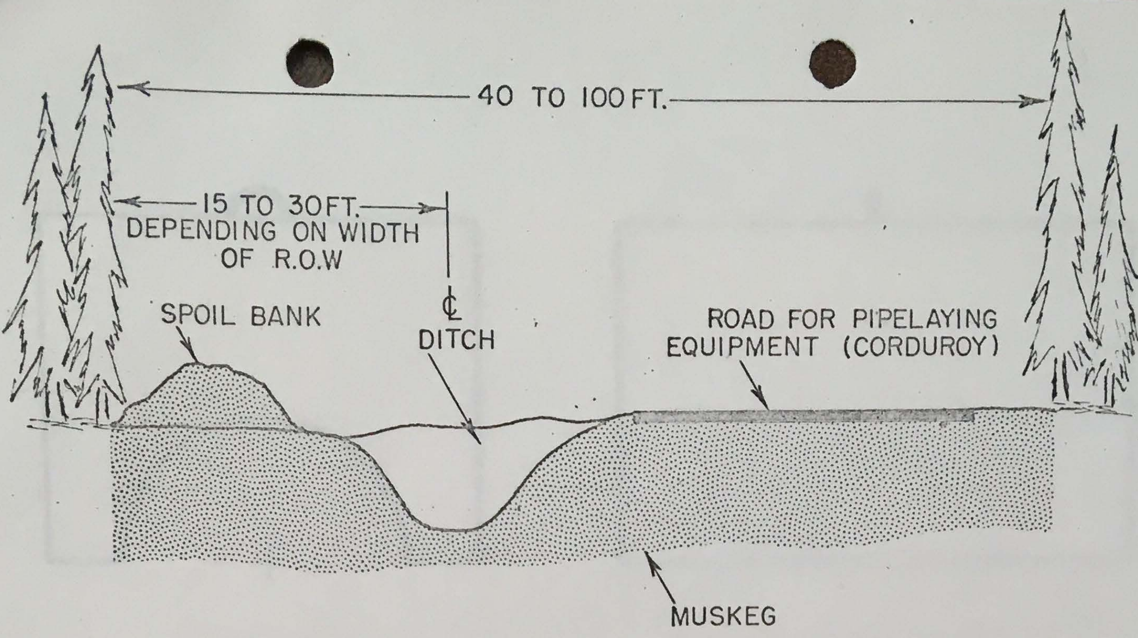
Anon. 1965, Winter Projects - Accidentally. Oilweek Nov. 22, pp41,42

Anon. 1966, Equipment Geared for Winter. Oilweek January 31.

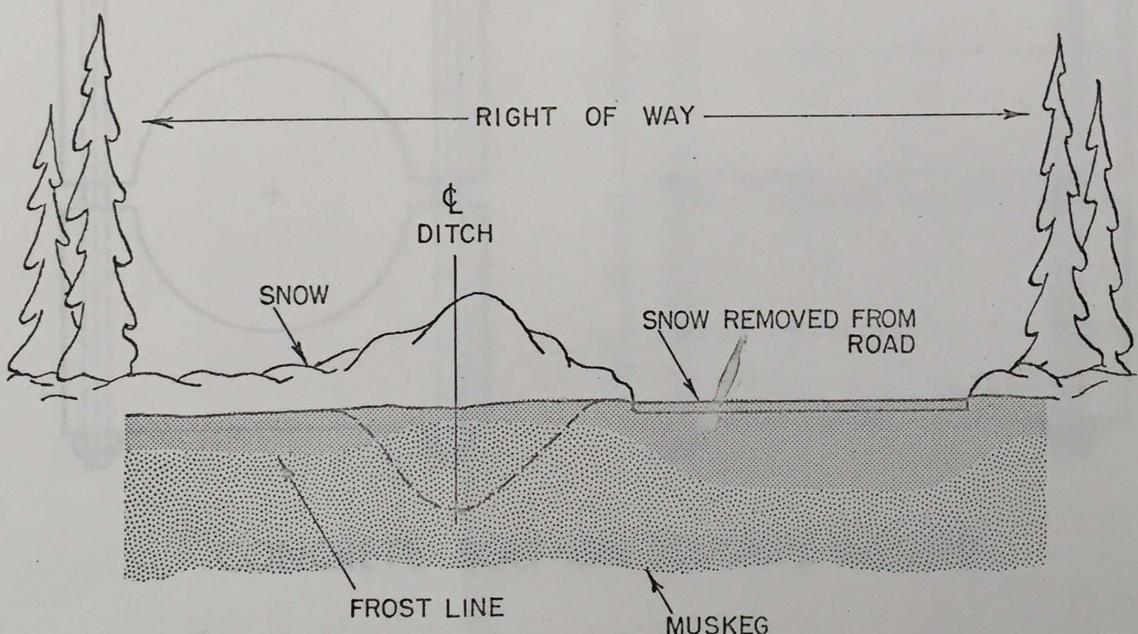
ROWLAND, L. O., 1966, Canadian Winter Job Makes Record Time. Pipeline Engineer January 1966.



PIPELINING IN MUSKEG (summer)

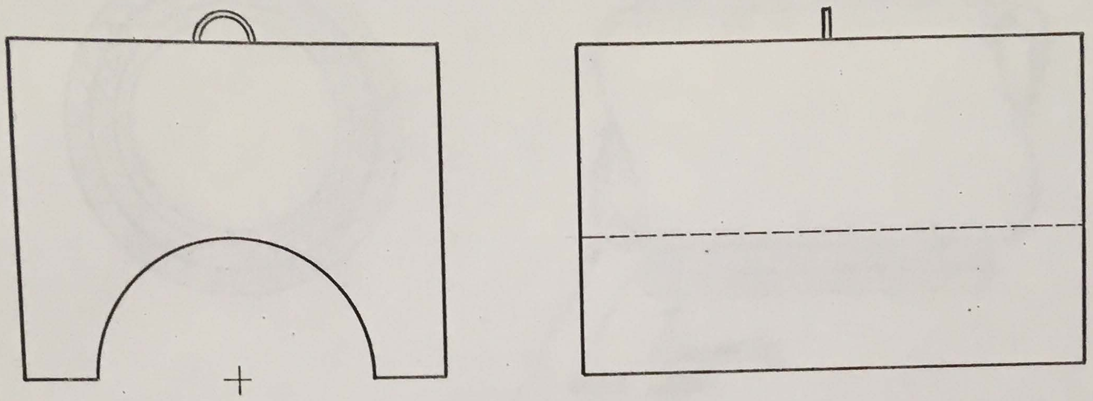
NOTE - DEPENDING ON FACTORS P/L R.O.W. MAY BE 40, 50, 60 UP TO 100 FT.
FACTORS - TERRAIN, LAND COST & AVAILABILITY, FUTURE LOOPING & EXPANSION PLANS.
CENTER LINE OF DITCH MAY VARY FROM LOCATION ILLUSTRATED IN SKETCH ABOVE, WHERE SPECIAL CONDITIONS EXIST.

FIGURE 1



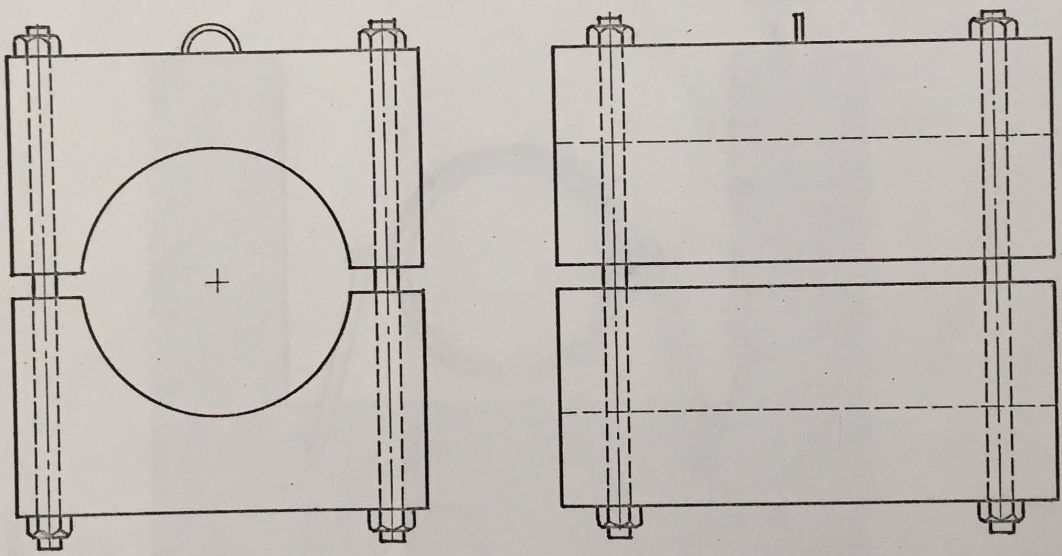
PIPELINING IN MUSKEG (winter)

FIGURE 2



CONCRETE SADDLE WEIGHT

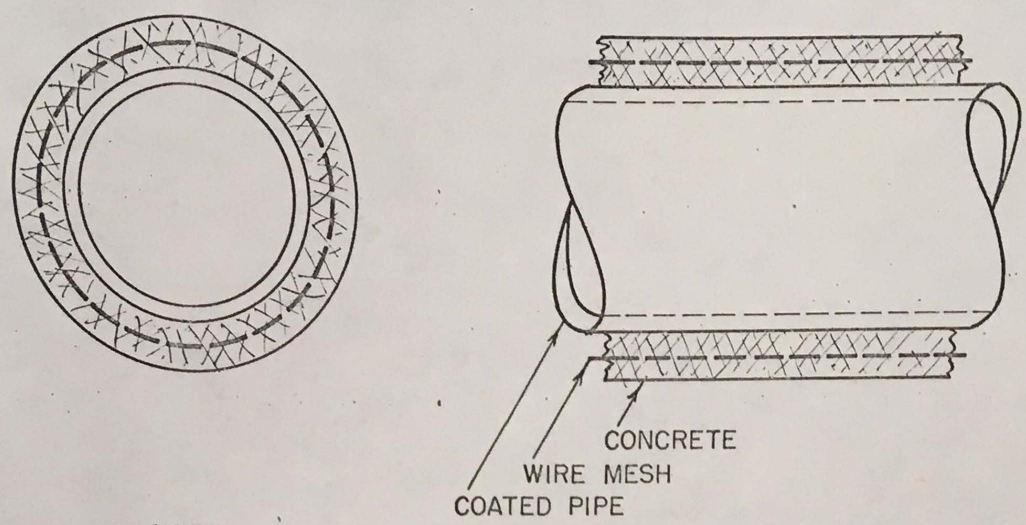
FIGURE 3



CONCRETE BOLT-ON (CLAMP) WEIGHT

PIPE WEIGHTING

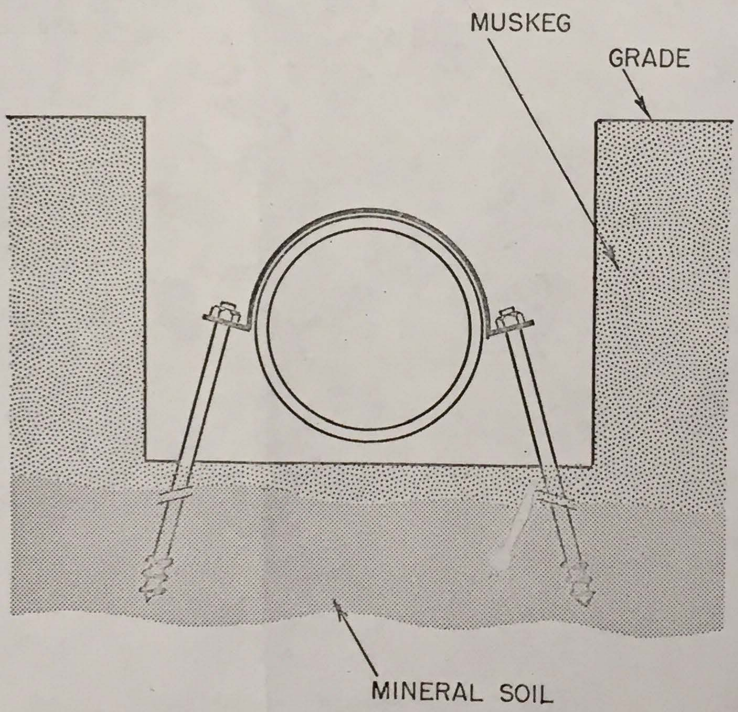
FIGURE 4



NOTE
USED MAINLY IN WATER CROSSINGS OR EXTREMELY WET TERRAIN.

GUNNITE (SPRAYED-ON CONCRETE) WEIGHTED

FIGURE 5



PIPE LINE ANCHOR

FIGURE 6

January 26, 1967

<u>Re: Arctic Pipeline Research</u>

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
339 50th Avenue S.E.
Calgary, Alberta

<u>Attention Mr. R.A. Hemstock</u>

Further to our letter of December 2, 1966 regarding research to be done by Travacon, Calgary for the Federal Government, we have attached another news clipping on the subject.

Yours very truly,

K.R. Shipley,

By:____________________
W. John Keys.

WJK/EG.
Encl.

January 26, 1967

Re; Pipeline Section - Muskeg Handbook

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
339 50th Avenue S.E.
Calgary, Alberta

Attention Mr. R.A. Hemstock

Dear Sir:

We have attached a re-draft on the subject of Pipelines which is to form part of a Handbook on Muskeg, the writing of which is being co-ordinated by the National Research Council.

I have taken the liberty of basically re-writing your draft to quite some extent since it was found that changing it did not work out very well because the overall section has been lengthened considerably. Since the size and nature of the Handbook is not known, this may prove to be too long, so please feel free to change it as you see fit.

Some additional ideas and experiences have been interjected in this write-up although the basic format of your draft has been followed. Some references have been listed, however these are mainly very general in nature and scope.

This Handbook should prove to be a useful guide and we shall be interested to hear further on it. Please feel free to call on us for any assistance we may provide and again, do not hesitate to modify this write-up as you deem necessary.

Yours very truly,

K.R. Shipley,

By:____________________
W. John Keys.

WJK/EG.
Encl.

January 26, 1967

7.4 Pipelines

Overland transportation of oil and gas has necessitated the contruction of a network of pipelines in Canada to provide the most economic means of moving large volumes over long distances. These pipelines cross many types of terrain, including muskeg. In fact, in many cases the oilfields are located in muskeg areas so that the gathering of oil and gas has raised difficult engineering problems in traversing this muskeg terrain.

In most areas, pipelining, like other types of construction, is preferably performed in warm weather. Where the bulk of the pipeline work is on mineral soil there is usually a definite economic advantage to do this type of construction, taking advantage of the warm and drier weather of summer and fall, since the conventional pipeline equipment and personnel perform most efficiently under these conditions. When muskeg is encountered it is usually possible to "power" your way through it, although this may be very costly and, as experience has shown, not necessarily the most desirable method.

Where muskeg is encountered in patches, where the line is not relatively long or where construction timing dictates, warm weather construction over muskeg can be undertaken. First the right-of-way is cleared through the muskeg areas, usually by hand, though light tracked vehicles with winches are a convenient help. Useable timber is placed beside the ditch centreline as corduroy. If necessary, additional poles are hauled in to completely corduroy the road area beside the ditch where ditching, stringing and laying equipment must travel. Light tracked vehicles for muskeg are used for emergency and the more difficult supply jobs. Ditching is done using backhoes or shovels, moving along the "road" and in very wet muskegs the trench sides are sloped very flat to reduce sloughing, also,the extent of ditching "ahead" is held to a minimum for the same reasons. Hauling, stringing, welding, coating and lowering are all done using conventional equipment and techniques as much as possible though modifications, such as load sizes, are made to suit conditions. Almost all pipelines in muskeg are weighted, as for river crossings, to create negative buoyancy, using concrete saddle or bolt-on weights. Where the muskeg is underlain with solid mineral soil, hold down clamps with earth anchors may be used to hold the pipe down.

Particularly where the muskeg occurs in patches, long lengths of pipe may be strung, welded and coated on solid terrain and pulled into place in the ditch which has been made by a backhoe on a "sled" being pulled across the muskeg. Tracked vehicles will place saddle weights on the pipe as required.

Where most of the pipeline - or, at least, extensive sections - are to be built across muskeg and there is some freedom in the timing of the job, it has been found better from both an economical and technical standpoint to work in the winter. The right-of-way is cleared of all brush and debris, preferably in the fall or the early part of winter, though this work may proceed well into the winter. As before, light tracked vehicles are useful in this clearing work though it remains largely a manual operation. After the muskeg has frozen sufficiently to support a light bulldozer, it is used to push the snow off the area to be used as a road and pile it over the ditch line. Some placing of corduroy on the very wet muskegs may be beneficial during this phase of the operation. This "snowploughing" allows the frost to penetrate deep into the road area and is effectively "grading" the right-of-way for equipment movement later, while the snow cover prevents the ditch line from freezing. As soon as the roadway is capable of supporting the heavy pipeline equipment, construction is started.

The snow is cleared from the ditch line area and conventional trenching machines will easily handle the light frost penetration that has occurred under the snow. Because trenching machines effectively"straddle" the ditch line special precautions may be necessary, such as extra wide tracks, temporary mats for the tracks or lightening (bearing part of weight of trencher) by large side boom tractors which are moving along the road. When a trencher cannot be used the ditch is dug by backhoe moving along the frozen road. The ditch will stand up well and, since all the equipment can work on and from the frozen road, very few problems are encountered. Except for extreme cold and stormy weather, cold weather construction techniques have been developed, such as preheating the pipe for welding, using two welders for each weld pass (in medium and large diameter pipes), keeping weld passes consecutive to minimize cooling in between, controlling post-weld cooling by wrapping pipe with insulating blankets, warming pipe for coating or using yard coated pipe so that only the joints require coating in the field, etc. For cold weather construction it is desirable to keep the pipe line spread in "tight formation" whereby all operations from stripping snow to clean up are less spread out. This reduces problems of trench filling with water which freezes, sloughing of ditch sides, freezing of spoil bank (ditch excavation material) which increases backfill and clean-up work. Though seasons will vary it has been found that the last half of January, February and March are ideal times for pipelining in muskeg.

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Muskeg classification systems or other evaluations can frequently provide valuable assistance in pipeline route selection. The shortest, most direct route is the first choice, regardless of soil or topography due to the cost of the pipe, coating, right-of-way, etc. The larger the pipe diameter the more this straight line route selection applies, due to the relation of the value of the pipe to other costs. However, deviations from the straight line, due to unfavourable terrain, access during and after construction etc. will often be found desirable both for economic and construction reasons. Here muskeg classification from aerial photographs can be of valuable assistance and is also very useful to the contractor as a guide in pricing the line, predicting trouble spots and planning the work.

The changing technology, improved equipment and techniques and the ingenuity of those responsible for construction have progressed a long way in overcoming the forbidding aspects of pipe line work in muskeg and, no doubt, this progress will continue.

WJK/EG.

January 26, 1967

Re: Project #482 & #483 - Arctic Pipeline Stresses

File: 9.666E

Mr. R.L. Bullock
Humble Pipe Line Company
P.O. Box 2200
Houston, Texas. 77001.

Dear Sir:

We wish to thank you for the information sent to us on the subject of strain gauges and your continued offer of assistance in this regard. We shall review this with a view to implementing it in our proposed test programme this year.

Yours very truly,

K.R. Shipley,

By:________________________
W. J. Keys.

WJK/EG.

HUMBLE PIPE LINE COMPANY
P. O. Box 2220
Houston, Texas 77001

P/L DIVISION
FILE No. 9.666 E
JAN 16 1967

January 10, 1967

TECHNICAL SERVICES DEPARTMENT

GEORGE G. HUGHES, JR.
MANAGER
A. V. CARDIN
ENGINEERING COORDINATOR
J. E. BARBEE
COMMUNICATIONS COORDINATOR
ROBERT L. BULLOCK
RESEARCH COORDINATOR

Attachments retained here on Project #483
WJK
7b

WJK
81.

7.8 PLR No. 482
Arctic Pipeline Stresses

Mr. K. R. Shipley
Imperial Oil Limited
111 St. Clair Avenue West
Toronto, Ontario

Attn: Mr. W. J. Keys

The attached information on strain gage techniques and equipment is for your consideration in the determination of Arctic pipeline stresses.

The methods and equipment presented are not the only ones in the strain gage industry nor are necessarily the best. It is felt that those presented will provide you with economical and reliable results.

We are prepared to assist you as this project progresses.

Robt L Bullock

BGW/sn
cc: Mr. H. C. Cook, New York
Mr. R. A. Hemstock, Calgary
Mr. R. H. Teskey, Calgary
Mr. C. Carlisle, Toronto
Mr. E. W. Christian, Edmonton

ARCTIC PIPELINE STRESSES

Gages

Micro-measurements, type SA-06-25RA-120, 45° rosette, 3-element, etched constantan foil gage, fully encapsulated, 1/4" gage length, self-temperature compensated. Although the gages are self-temperature compensated, they do have known small deviations with changes in temperature. This can be corrected by referring to the deviation factors with the gages. Refer to their catalog No. 20 for gage information and W. T. Bean Bulletin TG-10 for temperature measuring devices.

Adhesive

Type RTC (room temperature cure) epoxy adhesive with a curing time of 24 hrs. at 75°F + 1 hr. at 110-120°F. Heat cure can be obtained in 1 hr. at 175-200°F. Strict compliance with manufacturer's directions for surface preparation is necessary for a properly cemented gage. For adhesives and waterproofing items outlined below, refer to the brochure entitled Strain Gage Accessories and Techneques by W. T. Bean.

Waterproofing

Waterproofing is one of the most important phases of properly installing strain gages. Many gages have been lost by seemingly good waterproofing procedures. Moisture may cause a gage to give erroneous strain readings or even fail completely. A common weak point in waterproofing is poor adhesion of the waterproofing compounds to the gage lead wires that must pass through each coating. The procedure for waterproofing is to begin with a cemented gage on a clean pipe surface and build up the various waterproofing compounds in thin layers, each layer reaching beyond the last layer to clean steel and lead wires. Gagekote #2 is a solvent--thinned nitrite rubber that air dries in 30 minutes to a very

flexible and tough film. It retains this quality at cryogenic temperature. This should be applied to the bare gage. Two or three layers are recommended. GAGEkote #5 is a 2-component rubber-like epoxy resin for direct immersion in water, gasolines and oils. Cures in six hours at 75°F. An accelerated cure can be obtained in one hour at 150°F. Gagekote #5 should be applied over Gage kote #2 in multiple layers.

Mechanical Protection

Mechanical protection is required to protect the gages and waterproofing from the weight of the pipe, sharp objects in the ditch and overburden. The attached HPL drawing A-7813 can serve as a guide for providing mechanical protection and additional protection from water.

Gage Application

It is recommended that the gages be installed on individual pipe joints under controlled conditions before installation into the line. This recommendation is based on lack of experience of installing gages at low temperatures. Orientation of gages on the pipe is shown in HPL drawing A-7817.

Availability of Equipment

Numerous companies sell strain gages and all related equipment and instruments. One of the best known in the field, including consulting services, is the William T. Bean, Incorporated. The items described above and in the attached brochures are sold by this company.

Strain Indicator

Baldwin Type N strain indicator. This is a light weight transistorized portable instrument that is probably the most common device in the industry. A brochure is attached.

Switching Box

Baldwin Model PSA-20 - 20 point switching unit to provide hook up between individual gage elements and the indicator. This unit is a low resistance, triple pole twenty position switch. This is another common device in the strain gage industry.

Temperature Sensors

Micro-measurements, Inc. STG-50 Temperature Sensor with Vishay Instruments, Inc. LST Series Network. These sensors can be used for temperature readings during strain gage readings. This is used to correct pipe and gages for temperature.

Computer Programs

All Computer Manufacturers have programs for computing stresses from strain gage readings. Humble Pipe Line uses the Bell Telephone program (IBM 650) for computing maximum and minimum stresses, including direction, from 45° rosette strain gage readings. Direct contact with your computer manufacturer is advisable.

Gage Hookup

It is recommended that the "3-lead wire hookup" be used which eliminates the effect of temperature variations in the lead wires. This is further explained in "Strain Gage Instrumentation" by M.H.Aronson and R.C.Nelson. This book is attached. Refer to HPL drawing B-4459 for a typical instrumentation hookup.

Strain Gage School

A school on "Strain Gage Techniques-Lecture and Laboratory" will be held August 28-September 1, 1967, at University of California, Los Angeles, California. The director will be W.M.Murray of M.I.T. Refer to the attached brochure. More detailed information will be available 2-3 months before the starting date. This information has been requested and will be forwarded to you when received.

Strain Gage Experts

Mr. Tom Atterbury, Battelle Memorial Institute, Columbus, Ohio, is one of the foremost known authorities on strain gage techniques. He has offered to discuss the subject with us. It is recommended that he be visited for his comments after the proposal has been finalized.

BGW/sn
1-6-67

January 13, 1967

Mr. R. A. Hemstock
Imperial Oil Limited
Producing Department
11160 Jasper Avenue
Edmonton, Alberta, Canada

Re: U.S. Patent 3,292,647
Transporting Wax-Bearing Oil
in Pipelines

Dear Alex:

Enclosed is a copy of the recently issued U.S. Patent entitled "Transporting Wax-Bearing Oil in Pipelines", which is assigned to Shell Oil. This may be of interest to you in your work on the Study of the Movement of Crude Oil in Arctic Areas.

The patent covers the use of gas injection and/or pressure pulsations as a means for improving the flow characteristics, particularly start-up, of viscous oils.

Very truly yours,

Original Signed
H. C. Cook
H. C. Cook

HCC:ms
Enclosure
cc: Mr. W. J. Keys

P/L DIVISION
FILE No. 9.666E
JAN 18 1967

✓ ae

✓ 103. 70 JK

IMPERIAL OIL LIMITED

Esso

PRODUCTION RESEARCH & TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT

R. H. TESKEY,
MANAGER

339–50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

January 11, 1967

Mr. K. R. Shipley
Manager
Transportation and Supply Dept.
Pipeline Division
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Canada

Attention: Mr. W. John Keys

Dear Sir:

Re: Muskeg Handbook

The National Research Council is coordinating the writing of a "Muskeg Handbook of Engineering Practice" by engineers who have worked on muskeg problems in the past.

I have been asked to prepare a small section on pipelines which is a part of Chapter 7 on "Engineering and Construction Problems." The first draft of this is enclosed. Would you kindly review it and make whatever additions or corrections you think necessary. The article is probably too brief but I was not sure just how much pipeline technology should be included. Any contribution you could add in the way of tips or technique for muskeg would be appreciated. We should also include any good references you might know of.

Yours very truly

R. H. TESKEY

By R. A. Hemstock
R. A. Hemstock

RAH/mt
encl.

file 131.3
day

1 copy returned to work on wjk.

7.4 Pipelines

Distribution of oil and gas over long distances has necessitated the construction of a net of pipelines in Canada. Often these pipelines must cross muskeg. In fact, in many cases the oilfields themselves are in muskeg and the gathering of oil and gas has raised difficult engineering problems.

The first approach used is based primarily on the assumption that pipeline construction must be done in warm weather. It is a summer job. Moreover, where the bulk of the pipeline work is on mineral soil there is a decided economic pressure to use conventional pipeline equipment and simply power the way through muskeg when it is encountered. This may be a very costly process.

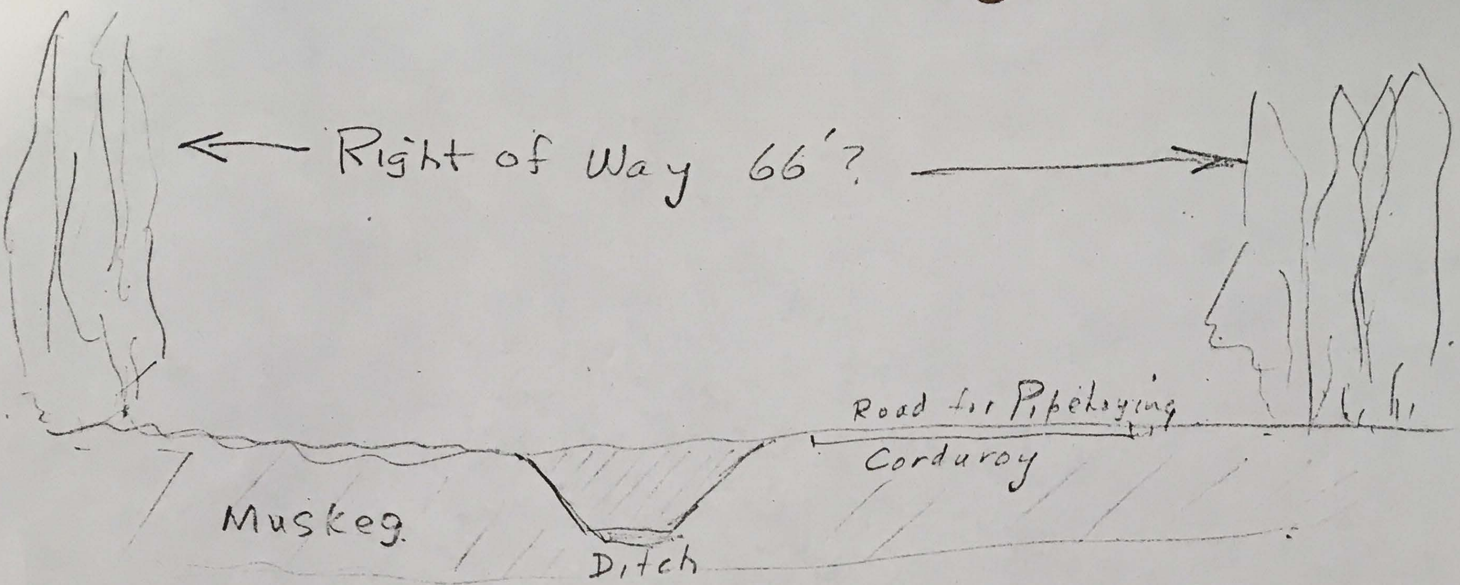
First the right-of-way is cleared (generally by hand) through muskeg areas. Useable timber is placed beside the ditch centreline as corduroy. If necessary, additional poles are hauled in to completely corduroy the road area beside the ditch where ditching, stringing and welding equipment must travel. Light tracked vehicles for muskeg are used for emergency and the more difficult supply jobs. Ditching is done using conventional equipment and in wet muskegs very flat slopes are left to prevent sloughing of the sides. In these areas pipelines are weighted as for water crossing. Hauling, stringing, welding and coating are done using conventional equipment and techniques as much as possible. These methods apply where jobs must be completed in the summer or where the longest portion of the pipeline is on mineral soil and there is an over-all economic incentive to work in summer.

Where most of the pipeline is to be built across muskeg and there is some freedom in the timing of the job it has been found better to work in winter. The right-of-way is cleared of all brush and debris, preferably in the fall. Then after the muskeg has frozen sufficiently to support a light bulldozer it is used to push snow off the area to be used as a road and pile it over where the ditch will be. This allows the frost to penetrate deep into the road area but prevents the ditch line from freezing. As soon as the roadway is capable of supporting the heavy pipeline equipment construction is started. Large conventional ditchers will easily handle the light frost under the piled snow, the ditch stands up well and other equipment will work with little problem on the frozen ground. Welds are preheated to avoid stresses due to temperature and pipeline coatings are put over warm pipe. It has been found that February and March are ideal months for pipelining in muskeg.

Techniques have been developed in Great Britain whereby cables and pipelines are plowed into muskegs or softer soils. A patented plow is used in which the depth of ditch is controlled by the approach angle of the cutting edge of the plow. The pipeline is well up on solid ground then attached to the plow and pulled into the opening ditch in about ½ mile segments. Winches are used to pull the plow and pipe. This system has been used on pipe up to 8" in diameter. It is cheaper than conventional pipelining and is relatively fast.

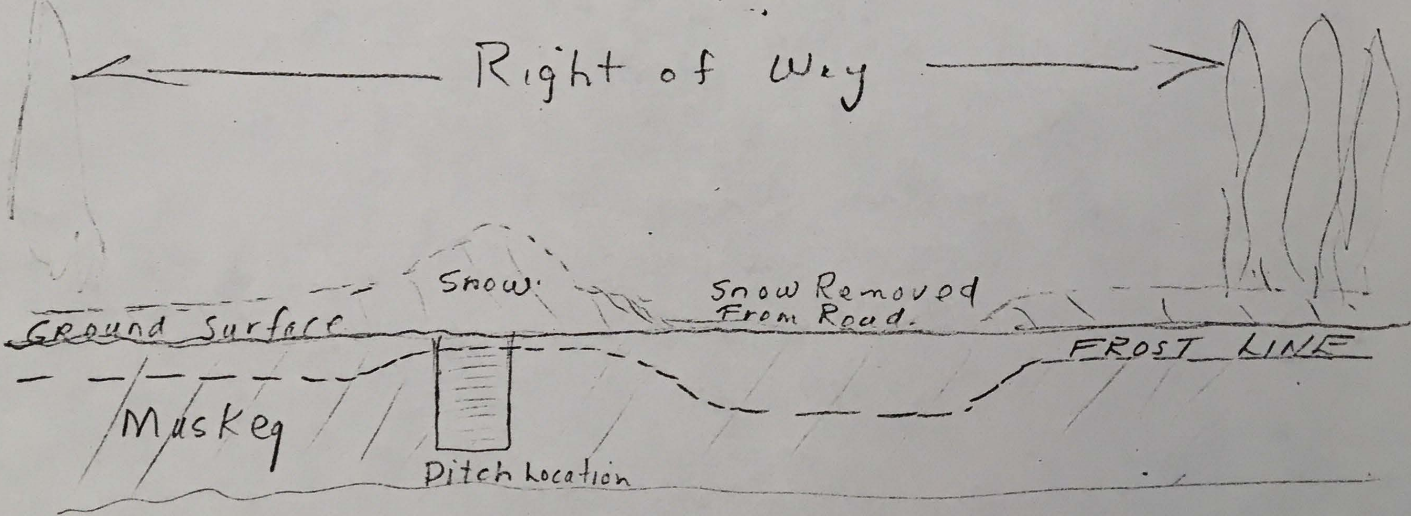
../2

Muskeg classification systems or other evaluations are generally not particularly adaptable to pipeline route selection since normally there are other overriding factors concerning the route. Usually the cost of the pipe is so great that the most direct route is chosen regardless of type of soil or topography. Classification is however useful to the contractor as a guide in pricing the line, predicting trouble spots and planning the work.



Pipelining in Muskeg. (Summer)

Fig 1.



Pipelining in Muskeg (Winter

Fig 2

IMPERIAL OIL LIMITED

Esso

TRANSPORTATION AND SUPPLY DEPARTMENT
WESTERN REGION

E. W. CHRISTIAN
PIPE LINE MANAGER

11160 JASPER AVENUE, EDMONTON, CANADA

December 20, 1966

Our Files 37.37
37.38

Your File 9.666E

Mr. K. R. Shipley,
Imperial Oil Limited,
Box 4029, Terminal A,
Toronto, Ontario.

Dear Sir:

With reference to your letters of December 12 and December 15, concerning a visit of Humble and Imperial personnel to the northern Rainbow extension project, the writer had already discussed the matter with Mr. E. R. Begole of Rainbow when he received your notification that Humble do not now plan on visiting this project.

Mr. Begole felt that the visit should be made after January 10, when winter construction is expected to be well under way. With proper scheduling, there could be overnight accommodation available for three people. He emphasized the desirability of co-ordinating this matter with him so that proper arrangements might be made.

The above information may be of some value in case any Imperial personnel wish to visit this project.

Yours very truly,

EW Christian

E. W. Christian

EWC/McB

c.c. - Mr. R. A. Hemstock, Calgary

P/L DIVISION
FILE No. 9.666E
DEC 22 1966

	NOTE	ACT	INITIAL
KRS	✓		KRS
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OMK			
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RDC			
CVH			
WJK	✓		WJK

DATE ANS'D 3/4/6.

January 5, 1967

<u>Re: 1966 PLR Annual Report</u>

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited,
339 50th Avenue S.E.
Calgary, Alberta.

<u>Attention Mr. R.A. Hemstock</u>

Dear Sir:

We wish to thank you for your letter of December 21, 1966 and attached progress report on your phase of Pipe Line Research Project #483.

For your information we have attached a copy of the report and abstract submitted to Mr. H.C. Cook earlier this week. As you will note, the report you submitted has been incorporated into the overall report with some abbreviations. You will be receiving a copy of the 1966 Annual Report from Mr. Cook when it is issued, later this month.

Yours very truly,

K.R. Shipley,

By:____________________________
W. John Keys.

WJK/EG.

Encl.

9.666E.

CROSS REFERENCE FILE FORM

SEE LETTER TO - H. C. Cook.

SEE LETTER FROM - W. J. Keys.

DATED - January 4, 1967.

FILED - 9.666

SUBJECT

1966 P.L.R. Report.

Esso

IMPERIAL OIL LIMITED

PRODUCTION RESEARCH & TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT

R. H. TESKEY,
MANAGER

339-50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

December 21, 1966

Mr. K. R. Shipley
Manager
Transportation & Supply Dept.
Imperial Oil Limited
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

Re: Project 483 - Arctic Pipeline Design and Construction Problems

We are enclosing a brief progress report on that part of project 483 that is the responsibility of the Producing Department.

Unfortunately, we have not yet received the letter from Mr. Cook, outlining the requirements of this report but due to the time limits noted in your phone call and the Holiday Season, we are forwarding this report. We hope that it provides the information you need.

Yours very truly

R. H. TESKEY

By RAHemstock
R. A. Hemstock

RAH/mt
attach.

file 662
day

P/L DIVISION
FILE No. 9·666 E

cc

3443.

RESEARCH PROJECT #483

ARCTIC PIPE LINE DESIGN AND CONSTRUCTION PROBLEMS

This research project was undertaken with the aim of developing economical techniques for the design, construction and operation of major pipelines in the Arctic and Sub-arctic areas of North America. To date information has been gathered by Imperial Oil Producing Department on soil temperatures in the Arctic and on the flow properties of crude oil at low temperatures.

A preliminary report "Pipelines and Oil Temperatures in Northern Canada" has been issued. This report summarizes oil temperature data from various sites in northern Canada. Since it was issued other data has been obtained, including information from various sites in Alaska.

Temperature probes have been installed in typical northern terrain at Norman Wells, Inuvik and Arctic Red River. These probes were installed in locations to give data on various soil types and various kinds of organic cover. Regular readings are being taken and a progress report will be issued in 1967.

Work on that phase of the project concerned with flow behaviour has been aimed at developing equipment and techniques for measuring flow properties under conditions expected in an Arctic pipeline. Specifically, the work so far has been designed to answer two basic questions:

a) what is the pressure drop in a given pipeline at a particular flow rate and temperature;

b) what difficulty could be expected in starting up a pipeline in which crude oil had cooled.

Both Newtonian and Non-Newtonian crude oils may contain waxes which complicate a laboratory study of flow behaviour.

Typical flow behaviour results have been obtained from several different crudes. Effort is presently being directed to measuring the yield strength of an isolated sample of oil in a capillary tube. Hopefully, this information will fix limits on the start-up pressure required in an oil pipeline. It is apparent that the flow properties of crude oils is a very complex subject and that there will also be difficulties in scaling up from laboratory to field equipment. Nevertheless, we believe that encouraging results have been obtained and plan to continue the program in 1967.

R. A. Hemstock
December 21, 1966

RESEARCH PROJECT #483

ARCTIC PIPE LINE DESIGN AND CONSTRUCTION PROBLEMS

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R. A. Hemstock
December 21, 1966

9.666 E.

CROSS REFERENCE FILE FORM

SEE LETTER TO - L. L. Bullock.

SEE LETTER FROM - W. J. Keys.

DATED - Dec. 16, 1966.

FILED - ~~9.9.~~ 9.666

SUBJECT

1966 P.L.R. Annual Report.

December 15, 1966

Re: Visit - Rainbow Pipe Line Construction

File: 9.666E

Mr. K.W. Christian
Imperial Pipe Line Co. Ltd
11160 Jasper Avenue
Edmonton, Alberta

Dear Sir:

We have just been advised by Humble Pipe Line Co. that they do not now plan on visiting the construction of theRainbow extension to the Bistcho Lake area. They feel that the methods of welding in cold weather are sufficiently well established that they are not likely to see any new techniques employed.

In view of this change of interest by Humble and the fact that we have experience in the field of cold weather welding, it is less probable that a visit will be planned as set forth in our earlier letter. However, it is suggested that you try to keep abreast of the work progress and conditions on this section of construction and advise so that the advisability of a visit be further considered early in the new year.

Yours very truly,

K.R. Shipley,

By:________________________
W. John Keys.

WJK/EG
cc. Mr. R.A. Hemstock, Calgary.

December 15, 1966

Re: Arctic Research

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
339 50th Avenue S.E.
Calgary, Alberta.

Attention Mr. R.A. Hemstock

Dear Sir:

We have attached a copy of a paper entitled "Pipe Line Flow Characteristics of Crude Oils". It was felt you may be interested in this though it may or may not have any new information in it.

Yours very truly,

K.R. Shipley,

By:______________________
W.J. Keys.

WJK/EG.

Encl.

MEMORANDUM

TRANSPORTATION AND SUPPLY DEPARTMENT
PIPE LINE DIVISION

December 15, 1966

Re: Arctic Pipeline Research

File: 9.666E

TO FILE:

Mr. R.L. Bullock, Humble Pipe Line Co. called on December 8, 1966 after he had received the copy of Mr. H.C. Cook's letter of December 6, 1966 relative to the above subject.

He could not see any value in the approach using a programme of mathematical stress analysis since it is known what stress limits a pipe can withstand and the effects on physical dimensions of thermal changes are known and predictable. He felt that little could be accomplished to determine the type and amount of stress that might be caused on a line constructed in the Arctic, using a mathematical analysis technique.

Essentially our feelings have been similar although we have agreed that we will certainly consider such an approach and look into it further.

In regard to Humble's phases of the project, he felt they would not go much further on the welding analysis. They feel that the techniques and methods have been tried and found very satisfactory in cold weather pipe line construction providing the conditions generally can be controlled to give satisfactory results. Thus, we should not set unnecessary limits and the Contractor should be given good scope to exhibit his ingenuity.

In corrosion, they have gathered information and evidence but there is more to do as to when to coat and when not to coat, type of coating, cathodic protection and how this can be achieved.

Mr. Cook will be visiting Humble this week and will review their future plans and whether the deferment of the test installation will cause them any concern.

W.J. Keys

W.J. Keys.

WJK/EG.

MEMORANDUM

TRANSPORTATION AND SUPPLY DEPARTMENT
PIPE LINE DIVISION

December 12, 1966

Re: Test Installation - Arctic Research

File: 9.666E

TO FILE:

Further to Memo to File dated December 5, 1966 on the subject of Arctic Research, Mr. A. Hemstock called on December 7 to advise as follows:

1. It has been agreed with their management that it is quite in order to hold up the test installation in the Inuvik area until 1967, probably late summer and fall. In essence, the urgency is not such that we need proceed at present.

2. Both Gerry Rempel and Alex have discussed putting in a test installation with Dick Hill, the head of the Research Centre (Federal Government) at Inuvik. He expressed keen interest in this as it portends opening up of these areas and, further, they are very willing to provide guidance, assistance and information re the installation and subsequent test programme.

3. Mr. Dick Hill advises that there is now very little equipment in Inuvik so that installation would be quite a problem during the coming period if we did plan to proceed. It would mean moving at least a major part of the required equipment in along with the material and also "manhandling" the pipe to a large extent.

4. Producing feel that the need to establish techniques and methods and to learn how to overcome the problems that will be incurred in laying a line in the Arctic is such that we should not let the Research Project falter, so it is essential that this test installation deferment not be misconstrued.

5. During the coming months we (P/L Div. and Prod'n Research) will work towards planning the test installation in as much detail as possible and will tentatively plan a meeting not later than March to review these plans.

W.John Keys.

WJK/EG.
cc. Messrs. K.R. Shipley,
C. Carlisle,
H.C. Cook, New York,
E.W. Christian, Edmonton.

December 12, 1966

Re: Visit to Rainbow P/L Constructiom
Northern Extension

File: 9.666E

Mr. E.W. Christian
Imperial Pipe Line Co. Ltd.
11160 Jasper Avenue
Edmonton, Alberta

Dear Sir:

It has been proposed that a visit to the winter construction of the Rainbow Pipe Line northern extension would be of informational benefit to someone from Humble Pipe Line in conjunction with their phase of welding, pipe installing and coating in the Arctic Research work.

It is presumed that the most opportune time to see these construction operations would be early in the new year. We would appreciate your advising on this proposed timing and it is hoped you could make any necessary arrangements for access and transportation for such a trip. Possibly personnel from this office and from Mr. A. Hemstock's group would be able to participate in such a visit, at least for a short period, though the Humble man may wish to stay on longer.

We have told Humble that we will keep them advised on this and thus will await your suggested timing in this regard.

As you will note from the attached memos, plans to proceed with the test installation in the Inuvik area have been deferred and will probably follow the normal course of action from summer on during 1967.

Yours very truly,

K.R. Shipley,

By:____________________
W. John Keys.

WJK/EG.
Encls.

HUMBLE PIPE LINE COMPANY
P. O. Box 2220
HOUSTON, TEXAS 77001

TECHNICAL SERVICES DEPARTMENT
GEORGE G. HUGHES, JR.
MANAGER
A.V. CARDIN
ENGINEERING COORDINATOR
J. E. BARBEE
COMMUNICATIONS COORDINATOR
ROBERT L. BULLOCK
RESEARCH COORDINATOR

December 5, 1966

7.8.3 Arctic Project

P/L DIVISION
FILE No 9.666E
DEC 8 1966
KRG ✓ KRG
CG ✓ CL
DMK
RAP
LDA
BMS
CJM
RBC
GVH
WJK ✓ WJK
DATE ANS'D 3321.

Mr. W. J. Keys
Imperial Oil Limited
111 St. Clair Avenue West
Toronto, Ontario
Canada

Dear Mr. Keys:

We agree with the decision to incorporate all information into one report on the Arctic Project and have attached the original of our report.

On the welding, we believe that the conclusions presented will hold under most cold weather conditions. The technique of preheating and control-cooling after welding makes welding under extremely cold conditions possible. There is the case, however, of controlling cold weather conditions for the welder, which we believe can be done with shelters. We therefore decline the invitation to see the Rainbow extension. You will be close to the job and no doubt will be aware of any new welding techniques employed.

On the subject of corrosion, we have reviewed the Westcoast Transmission Company's paper entitled, "Corrosion Control of Pipe Line Systems in the Far North," and find no information that would change the conclusions presented in our report. Westcoast coats and cathodically protects all buried pipe.

Glad to hear that you will be taking advantage of the Strain Gauge School. Believe this is the best way to get information for the pipe testing problems.

Yours very truly,

Robt L. Bullock

RLB:tms
attachment

cc: Mr. H. C. Cook
Central Records

Report No. PLR-F-99-66

ARCTIC PIPELINE DESIGN AND CONSTRUCTION

WELDING AND CORROSION

RESEARCH SECTION

TECHNICAL SERVICES DEPARTMENT

HUMBLE PIPE LINE COMPANY

HOUSTON, TEXAS

Report No. PLR-F-99-66

ARCTIC PIPELINE DESIGN AND CONSTRUCTION

WELDING AND CORROSION

FOREWORD

This is an interim report on PLR Project 482, "Arctic Pipeline Design and Construction, Welding and Corrosion," and covers the work assigned to Humble Pipe Line Company by Imperial Oil as part of the Pipe Line Research Program conducted and coordinated by Esso Research and Engineering Company under the terms of its Pipe Line Research Agreement with affiliated companies of the Standard Oil Company (NJ).

ABSTRACT

This report discusses the welding of pipelines in the Arctic region during extreme winter weather and the corrosive environment found there in relation to pipelining. Recommendations are presented for conducting pipeline welding under Arctic winter conditions and for controlling aboveground and underground corrosion in the Arctic region.

Distributed By

PIPE LINE RESEARCH

TRANSPORTATION COORDINATION

STANDARD OIL COMPANY (NJ)

DECEMBER 1966

ARCTIC PIPELINE DESIGN AND CONSTRUCTION

WELDING AND CORROSION

Interim Report of Work Done by

HUMBLE PIPE LINE COMPANY

F. A. Therrell
Author

The purpose of this project is to investigate winter welding problems and corrosion problems that exist in the Arctic region and to present recommendations for welding procedures and corrosion control measures to overcome these problems.

CONCLUSIONS

Low temperature winter welding presents three problem areas no matter whether the welding is being done in the Temperate, Sub-Arctic or Arctic regions. The severity of these problems may vary somewhat depending on the geographic location but not to the degree commonly thought of, as will be pointed out in the discussion. The specific problem areas deal with human, mechanical and metallurgical factors. With proper attention and precaution directed to these factors, there seems to be no lower limit to the ambient temperature at which satisfactory welding can be performed.

Corrosion experience is more directly related to geographic location over land masses in relationship to temperature and humidity. In this respect, atmospheric corrosion has less bearing than underground corrosion. For example, atmospheric corrosion is quite low in desert areas and decreases appreciably as one goes inland from coastal areas into areas of drier and colder climates. This condition exists throughout the Arctic region and very minor atmospheric corrosion is encountered. Long term protection can be obtained by the use of low cost coating systems such as an alkyd base paint.

Underground corrosion, however, decreases only slightly as the colder regions are encountered up to the permafrost line. Permafrost being permanently frozen land mass. Experience and experimentation have shown that virtually no corrosion is found on metal structures located in permafrost. For this reason, as well as stable mechanical and thermal forces acting on the pipeline, it would appear that the best location of a line would be in permafrost wherever possible. In unfrozen soil and climafrost, soils alternately frozen and thawed, corrosion forces would have to be countered by using a pipe coating and cathodic protection.

DISCUSSION

A literature search and personal interviews with construction and operation personnel of Sub-Arctic and Arctic pipelines were made to investigate the problems of low ambient temperature welding. Both sources indicate that when proper precautions are taken, welding can be carried out at very low ambient temperatures. These precautions cover man, machinery and metallurgical factors. The documented low temperatures range down to -52°F for manual welding and -80°F for machine welding.

Much study and investigation have been done on the physical and psychological effect of cold on man. This work has shown that man's productiveness is adversely affected by extended exposure to low temperatures. For example, the sense of touch is reduced and the sense of sight must step in to assist man in normal hand operations. When man's sight is impaired under such conditions, as it is under a welder's hood, his dexterity and sureness of hand suffer. Further study along this line, however, shows that man can be properly clothed, sheltered and worked on a schedule that will allow quality work in these low temperature ranges. Training of the worker to live and work in the Arctic environment puts him in a frame of mind to cope with the cold and to get on with the job. Information along this line is available from several sources. One of the better booklets published was done by the Defense Research Board, Department of National Defense, Canada, as a guide for men working on D.E.W. line construction.

The low temperature limit set in some welding codes appears to be based on the idea of welder comfort and its effect on welding quality. This concept has some validity and emphasizes the reason for providing welder comfort as well as looking after the other people on the construction crew. It has been more or less industry practice, particularly drilling, to shut down outside work when the ambient temperature gets down to -55°F. Assuming that proper provisions are made for the human element, it is reasonable to say that welding can also be done at this temperature.

Interestingly enough, this -55°F temperature range is just as applicable to the northern part of the United States as it is to Canada or Alaska or even the North Pole. Numerous points in the U. S. repeatedly experience lower temperatures than the normal low of -55°F recorded at the North Pole. Of course, the extended period of cold is much longer as you go north; however, the coldest temperature recorded on the North American Continent was registered as -83°F at Snag, Yukon Territory. This location is several hundred miles below the Arctic Circle.

Ground temperature and ambient temperature data have been collected at a number of locations in the general vicinity of a proposed Alaskan pipeline route from the northern slope of the Brooks Range south to tidewater. These reports indicate a normal low ambient temperature range of -20°F to -40°F.

Wind affects welding no matter what the temperature is and most welding codes have a clause covering this. As the temperature drops, wind has an increasingly important effect on man and is referred to as chill factor. This simply means that at a given ambient temperature, a man exposed to wind will experience a lower relative temperature and this temperature level will decrease as

as the wind force increases. Therefore, it is evident that some form of shelter is required to protect man under windy conditions as well as to allow stable conditions for the welding process. The next step beyond this would be to heat the shelters whenever the combination of wind and temperature reached the point that affected welding quality. Fortunately, much of the area under immediate attention does not normally experience wind velocities over seven miles per hour during the winter months.

Machinery and equipment are also affected by low temperatures. Military and industrial activity in the Arctic region has done much to reveal the precautions necessary to work in this environment. This discussion will be limited to that machinery and equipment associated with welding although the winterizing program is applicable to practically everything on a construction spread.

Welding machines need to be in top condition on any job and this is even more imperative in the remote Arctic region. A good maintenance program is a must including heated working shelter for the mechanics. It has been found that engines are better off to run constantly unless heated shelter is available. Of course, low temperature lube oils and greases are required for trouble-free lubrication. Bronze bearings or equivalent should be changed to steel roller bearings to prevent binding at the low temperatures. Cable leads require a suitable low temperature insulation that will provide adequate flexing. This problem can also be approached from the standpoint that increased electrical conductivity of the cable leads at the lower temperatures allows the use of smaller cable than that normally used at higher ambient temperatures. Acetylene cylinders are greatly affected by low temperatures. Heated storage of the cylinders should be provided equal to the charging temperature. Electrodes are best stored in unheated shelters or in cabinets with controlled humidity. Welding hoods and hand shields are also best stored in unheated shelters. Some operators prefer the hand shield for winter welding due to the head band adjustment over bulky head gear and the frosting over of the lens from the breath. These problems stated above are by no means all to be considered in low ambient temperature welding but should suffice as a guide for consideration in Arctic work.

The third factor to consider in Arctic winter welding deals with the metallurgical soundness of the weld. Laboratory tests and field experience have shown that low ambient temperature welding is influenced almost entirely by the increased rate of cooling resulting from the lowered temperature condition. From these same sources it has been found that a general solution to this problem is to increase the over-all heat input to the welded joint to slow down the cooling rate. A widely used guide for this increased heat input amounts from 5 to 8% for every 18°F drop in ambient temperature below the normal ambient.

A number of ways are available to realize this increased heat input. Preheating is probably the most common method used. Increasing electrode size or the welding current, or decreasing the travel speed are other methods that can be used. Another widely accepted method is the use of low-hydrogen electrodes. Tests and experience have shown that fewer failures occur in the heat affected zone with the use of the low-hydrogen electrodes. Some codes and specifications require that a weld be completed within a given time once it is started. Blanketing a weld with an insulating material has also been used

with good success. Combinations of these methods have also been used to realize the desired results of controlling the cooling rate.

Therefore, it can be seen that incomplete preparation of men and/or machinery and inattention to the complete welding process can affect welding production and quality. These matters must be realized and adequately dealt with for a successful welding program in low ambient temperatures. When this is done, the temperature limit for Arctic welding will be related to the suitability of the working conditions and welding procedure that are provided.

Corrosion problems in the Arctic region are found to be minor. Besides making a literature search on this subject, a field trip was made to investigate actual conditions in the western portion of the Northwest Territory, the Yukon Territory and a good portion of Alaska. See Figure 1 for the area covered plus the location of points from which temperature data reports have been obtained. Similar temperature data is being collected by Imperial Oil in the Canadian Territories.

Atmospheric corrosion was found to be very minor throughout the entire area investigated. Many bare iron and steel structures along the open sea at Tuktoyaktuk, Barrow, Nome and Kenai Peninsula showed little evidence of any atmospheric corrosion. Of course, under these conditions, coated structures were in excellent condition.

Experience on underground corrosion in the Arctic region was found to be rather limited. Outside of the general coastal areas of Skagway, Haines, Anchorage and Nome, the only buried lines found were at Norman Wells, Dawson City, Whitehorse and Fairbanks. Corrosion on the lines witnessed at these locations was slight to moderate. The oldest buried line investigated was a 48-inch water siphon line that was installed in 1903 near Dawson City, Yukon Territory. Although this line has been out of service for many years, there is still very little corrosion. The only evidence witnessed of severe corrosion resulting in a leak was on some pipe removed from a muskeg area near Haines on the military products line built from there to Fairbanks in 1956. Pipe replaced through this area was coated with a plastic tape and anodes were scheduled to be installed for cathodic protection. A number of aboveground lines were inspected that dated from 1942 back to the early or mid-1920's with no record of a corrosion leak.

In the areas further north from the immediate coastal areas of southern Alaska, the permafrost is generally found within a few inches of the ground surface, particularly where the ground cover is not disturbed. Considerable research investigation with piling in permafrost has been conducted by the Arctic Field Station just outside of Fairbanks, Alaska. This is in conjunction with the U. S. Army Cold Regions Research and Engineering Laboratory, Corps of Engineers, Hanover, New Hampshire. Their investigations have shown no corrosion on steel piling in the permafrost zone. This experience prompts us to consider laying a line in permafrost or in such a manner as to promote the formation of permafrost around the line. The evidence of corrosion in the climafrost area would dictate that coating and cathodic protection be used on buried lines in these areas. Although the evidence does not demand coating lines aboveground, it may be beneficial to use a white or aluminum coating on such lines to help reduce thermal movement.

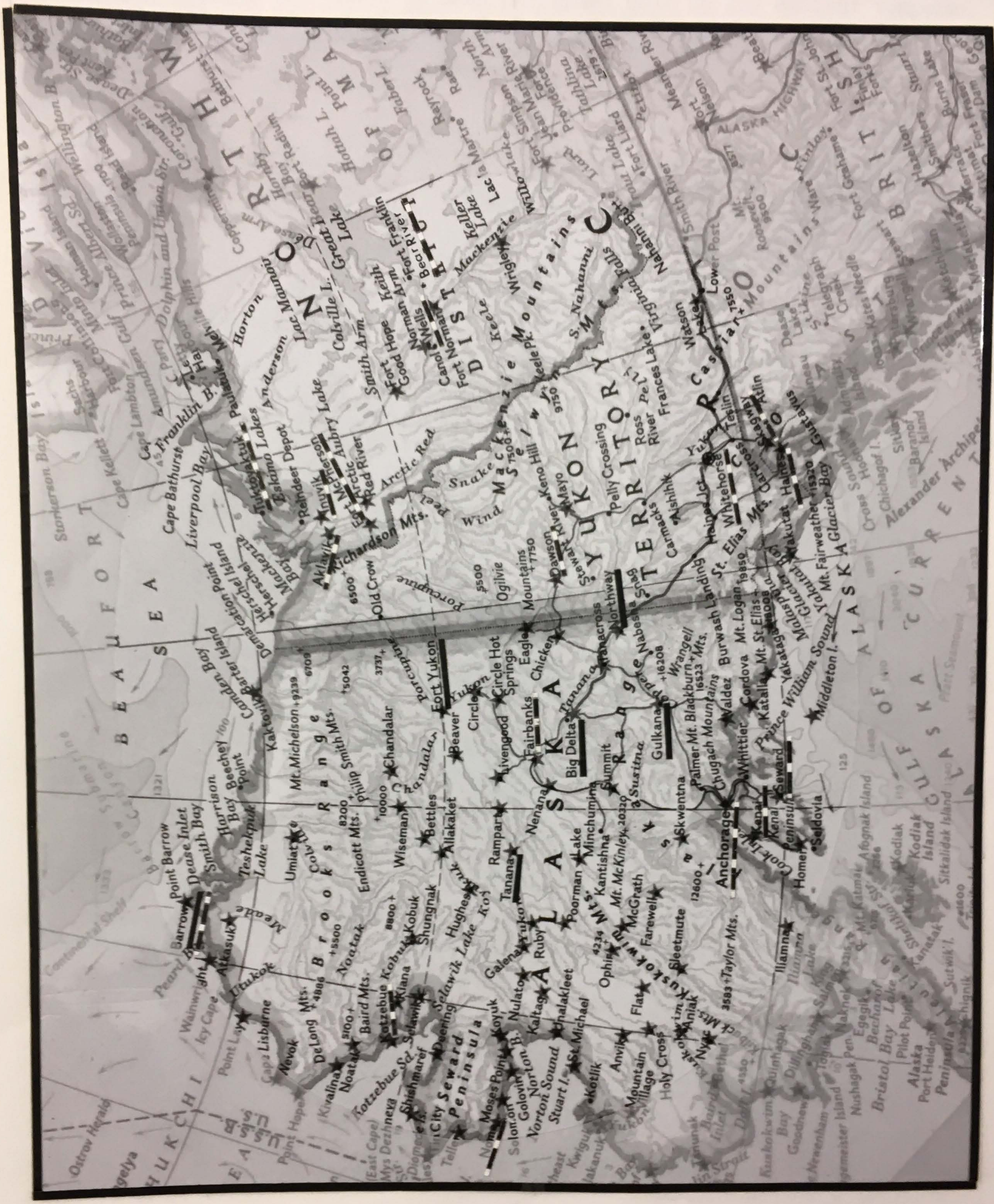

Figure 1 Arctic Region Investigated. Broken lines show locations investigated for corrosion. Solid lines show temperature data locations.

Two coating systems are known to have performed well in low ambient temperature construction work. Yard-applied X-Tru-Coat has been used on pipe up to 20 inches in diameter with tape being used for the field joint coating. Plicoflex tape has been successfully applied to 20-inch pipe over-the-ditch at ambient temperatures ranging as low as -30°F.

SUMMARY AND RECOMMENDATIONS

Welding

The three factors to be considered with low ambient temperature welding are human, mechanical and metallurgical. We can make more or less a general recommendation for the first two factors in that they must be winterized to a degree consistent with the Arctic weather to which they will be exposed. One advantage on the human side is that man can be taught to live and cope with the weather when properly provided.

The metallurgical aspect of this problem is almost totally influenced by the rate of cooling of the weld. Three steps are suggested to overcome this problem. The first of these is to preheat the entire weld area to a point specified by the welding inspector or as set forth in the specifications. This may vary as the ambient temperature varies. Secondly, the weld should be completed in as short a time as practical after it has been started. Finally, the completed weld should be covered securely at least one foot to either side of the weld joint with insulating material adequate to control the cooling of the weld to the satisfaction of the welding inspector. As a guide, this would require a time interval of approximately one hour, but here again, this could vary with ambient temperature.

An additional step that could be taken as a part of the welding specification would be to specify the use of low-hydrogen electrodes such as the E-7016. An additional step that must be taken in the event that wind or temperature or combination of both, creates unsatisfactory welding conditions is the sheltering of the welding stations. This may also require heated shelters in extreme cases.

No shut down temperature is specified as related to the welding phase of the work. This decision will have to rest with the welding inspector based on the performance of the welders and the resulting finished welds.

Corrosion Control

Atmospheric corrosion is very minor in the Arctic region. Tanks, machinery, fittings, manifold piping and other aboveground piping need not be coated except for appearance and good housekeeping operations. Machinery, fittings, and prefabbed manifold piping would be recommended shipped with a shop-applied oil base alkyd primer. The finish coat on this equipment and material as well as the complete painting of tanks and other aboveground piping could be done the first summer season that it would be convenient to do so.

Pipe buried in unfrozen soil or the climafrost zone should be coated with X-Tru-Coat or Plicoflex tape or some similar tape system requiring a primer. The specific selection should rest on the economics of the different systems.

Neither asphalt nor coal tar enamel type coatings are recommended in this environment.

Pipe buried in permafrost, or in such a manner that permafrost will form around the pipe, need not be coated. However, if the operation of the line required heating of the product, then a coating would be required throughout. In this case the use of polyurethane foam should be considered in the over-all economics of investment and operating cost.

CABLE ADDRESS "RESEARCH"
ADRESSE TÉLÉGRAPHIQUE

PLEASE QUOTE FILE No. I-13,756
No DE DOSSIER À RAPPELER

NATIONAL RESEARCH COUNCIL
CONSEIL NATIONAL DE RECHERCHES
CANADA

DIVISION OF BUILDING RESEARCH
DIVISION DES RECHERCHES EN BÂTIMENT

OTTAWA 7.

5 December 1966

Mr. K.R. Shipley, Manager,
Imperial Oil Limited,
Transportation and Supply
Department,
Pipe Line Division,
111 St. Clair Avenue West,
Toronto, Ontario.

Attention Mr. W.J. Keys

Dear Sir:

My sincere apologies in the delay in replying to your letter of October 14, 1966. I have just returned to Ottawa after an extended trip overseas followed by a field period in Northern Manitoba, hence the reason for the delay.

I have noted that your group is now actively engaged in the study of design, construction and operation of petroleum pipe lines in northern areas previously handled by W.W. Boucher. As further information is obtained we will most certainly bring it to your attention. I look forward to meeting with you to discuss problems associated with the above whenever it may be convenient.

Yours faithfully,

G.H. Johnston

G.H. Johnston,
Northern Research Group.

GHJ/ab

66-N-264

P/L DIVISION
FILE No. 9.666E
DEC 8 1966

	NOTE	ACT	INITIAL
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Esso

IMPERIAL OIL LIMITED

COMPTROLLER'S DEPARTMENT

JOHN CORNWELL
Eastern Region Comptroller

A. S. LEHMAN
Eastern Region Assistant Comptroller

Don Mills Road at Eglinton, Don Mills, Ontario

November 29th, 1966.

K. R. Shipley,
Transportation & Supply-Pipe Lines Division,
111 St. Clair Ave. W.,
Toronto, Ontario.

Dear Sir:

In reference to our letter dated December 1st, 1965 we wish to advise that the balance of October 31st, 1966 in Account #90-450-0006 "Artic Pipe Line Design & Construction Problem" is as follows:

Office Supplies	$127.02
Travelling Expenses	$1,255.57
Other Charges from Imperial Oil Departments	$12,830.04
Inspection Lab Charges	$ 873.97
TOTAL:	$15,086.60

We trust that the above information will assist you in reconciling this account to date.

If additional information is needed please do not hesitate to contact the writer.

Yours very truly,

JOHN CORNWELL.

M. A. Wallis/gx

c.R. to 9.301 wjk → ?

J. A. Kelleher/tj
Dept. 5.5

P/L DIVISION
FILE No. 9.6.6E
DEC 2 1966

	NOTE	ACT	INITIAL
KRS	✓		KRS
CC	✓		CC
OMK			
RAP			
LDA			
BMB			
CJB			
RDC			
CVH	✓		CVH
WJK	✓		WJK

DATE ANS'D 3285.

Phone Don Burrows for up to date info
[illegible]

M E M O R A N D U M

TRANSPORTATION AND SUPPLY DEPARTMENT
PIPE LINE DIVISION

December 7, 1966.

Re: Arctic Research

File: 9.666E

TO FILE:

Mr. H.C. Cook called on December 5 to inquire on the status of the test programme on the Arctic Research. The information contained in the memo to file re the conversation with Mr. A. Hemstock was outlined, and a copy of that memo was forwarded to him.

Mr. Cook is going to Houston the week of December 12 and will review with Humble the aspect of holding off on the test installation. He felt that this will be agreeable to them since he believes that urgency in the Alaska area is likewise reduced.

A number of technical construction aspects were discussed, such as pipe insulation, oil temperatures downstream of a station and their effect on soil surrounding the pipe, stress calculations that may be possible in addition to, or in place of, a test installation etc. Mr. Cook will outline a number of these points and forward them to us for consideration in our test and research work.

W. John Keys.

W. John Keys.

WJK/EG.

December 7, 1966

Re: Seminar on Strain Gauges

File: 9.666E

Humble Pipe Line Company
P.O. Box 2220
Houston, Texas, 77001.

Attentiom Mr. Bill Walton

Dear Bill:

Further to my letter of November 22, 1966, Alex Hemstock advises that, due to committments on other work, they are unable to release a man at that time to attend the seminar in University of Miami on strain gauges.

It is improbable that we will be able to have anyone else attend at this time, though if you hear of a similar course at this or another school a bit later in 1967 we would very much appreciate being informed so that we may consider it at that time.

Yours very truly,

K.R. Shipley,

By:____________________
W. John Keys.

WJK/EG.

Standard Oil Company

INCORPORATED IN New Jersey

30 ROCKEFELLER PLAZA, NEW YORK, N.Y. 10020

Transportation Coordination Department

H. C. COOK
Manager, Pipe Line Research

December 6, 1966

Mr. W. J. Keys
Imperial Oil Limited
111 St. Clair Avenue, West
Toronto, Ontario, Canada

Pipe Line Research Project -
Arctic Pipelines

Dear John:

With reference to our telephone conversation on Monday, I have been reviewing the objectives and plans for the proposed field tests on buried pipe in Arctic locations, as outlined in the Minutes of the Calgary Meeting on Arctic Techniques.

In the light of the inconvenience and cost of the setting up of these field tests in the Far North, it is suggested that you consider conducting a Program of mathematical stress analysis to determine at least the most severe stress conditions which can be contemplated in long pipelines traversing permafrost areas, prior to conducting field tests. It certainly would not be possible to simulate exactly the conditions, however, the stresses calculated would provide boundary conditions and indicate the maximum stresses that could be expected.

An additional problem worthy of some consideration, is the determination of the possibility and extent of movement of the warm pipeline in permafrost due to the formation of a molten layer surrounding the uninsulated pipe. Is it necessary to keep the pipe surface at a temperature below freezing, either by the protective coating or actual insulation in order to prevent this melting and movement (downward or upward, depending upon the buoyancy factor)? If a sample pipeline section were to be put in a northern location, it may be desirable to circulate warm liquid through it to determine this effect. Here again, the analytical work will be useful in determining the magnitude and seriousness of the problem.

We certainly agree that we should make every attempt to accumulate good engineering data as soon as possible on this project, however, the results of the field trials may be more worthwhile if they could be delayed until analysis work has been completed to determine the maximum stress limits possible.

Very truly yours,

H. C. Cook

HCC:ms
cc: Mr. R. L. Bullock - Humble Pipe Line Co.

December 6, 1966

Re: Corrosion in Far North
File: 9.666E

Mr. H.C. Cook
Standard Oil Co. (N.J.)
30 Rockefeller Plaza
New York City, N.Y. 10020

Dear Sir:

We have reviewed the article entitled "Corrosion Control of Pipe Line System in the Far North" forwarded to us on November 22, 1966. This appears to be a good treatment of the subject of internal corrosion due to handling sour gas, that is high in H2S and moisture.

Although this is an area we will have to keep under consideration it is felt we are not likely to encounter such severe conditions in handling crude. It has been our experience in Western Canada that handling sour crude in a continuously operating trunk line does not result in any tangible internal corrosion problem. These have been some cases of corrosion leaks in field flow lines operating intermittently, particularly those where salt water was present in the crude.

We do not have any person who is expert on the matter of stress-corrosion cracking or hydrogen-stress cracking. Perhaps someone in Humble or E. R. & E. could review this to assess the accuracy of the information and whether we might expect to anticipate any similar circumstances or conditions.

Yours very truly,

K.R. Shipley,

By:________________________
W. John Keys.

WJK/EG.

MEMORANDUM

TRANSPORTATION AND SUPPLY DEPARTMENT
PIPE LINE DIVISION

December 5, 1966

Re: Arctic Research
File: 9.666E

TO FILE:

Mr. A. Hemstock was called on November 30, regarding current work on the Arctic Research project and the following items were discussed.

1. A visit to the construction of the northern extension of Rainbow Pipe Line will be beneficial to help to assess winter construction techniques and it was agreed Humble, who are handling this phase of welding, could gain considerable knowledge from such a visit. Alex would like to be notified also in case he, or someone from his group, wanted to go along on such a visit.

   Regarding the existence of permafrost in this area, he advised that, if any, it would be sporadic, occurring only in patches, probably in swamps where the soil is uniformly organic and cover is lacking. There might be some more permafrost very deep but this is likely to be discontinuous type. Hay River is about the south fringe of permafrost in this longtitude and even there it is basically discontinuous. Therefore it was his opinion that any testing we might contemplate, similar to that planned for Inuvik, would be of no value.

2. The proposal to proceed with the test installation at Inuvik this winter has been discussed with Gerry Rempel who is co-ordinating their Arctic exploration work. Gerry advised Alex (Co. confidential information) that exploration in the Arctic had slowed very much. Due to effects of Rainbow and shortage of cash available to Imperial (and industry in general) they contemplate drilling only where and to the extent that their lease committments require in the Arctic (federal) areas during this coming season.

   Alex plans to discuss this with Walt Dingle during the coming few days and will advise more definitely on it at that time.

   Alex advises that in general Producing management feel that the PLR programme is good and essential and though the urgency is down at present, interest can flare up at any time and we should be as prepared as possible. We can no doubt do a better job of setting up a test programme by waiting until next year and it is expected that this timing will be adequate from present appearances.

3. The use of mathematical models and a computer programme for stress analysis was discussed and it was agreed that both would look at this more extensively. However, as presently considered, it was not felt to be applicable. Basically there is not enough information of a statistical nature to prepare a programme as yet.

   Alex advised that they have recently obtained considerable information from some Russian work done on stresses, ice crystal growth, permafrost, etc. re Arctic lines. The Russians have done some mathematical analysis in this and, over the coming weeks, they will be evaluating this and reporting on same.

W. J. Keys

W. John Keys.

WJK/EG.
cc. Mr. K.R. Shipley and Mr. C. Carlisle.
SONI.

December 2, 1966

Re: Arctic Research

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
Western Region, Producing Dept.
339 50th Avenue S.E.
Calgary, Alberta

Attention Mr. R.A. Hemstock

Dear Sir:

The attached News Item outlines plans for a study on northern transportation and access routes to be handled for the Federal Government by a Calgary research company. In case you had not heard of this we felt it would be worth while to bring it to your attention as you may hear of their work or progress on this undertaking.

Yours very truly,

K.R. Shipley,

By: ____________________
W.J. Keys.

WJK/EG.
Encl.

NEWS ITEM READS: OTTAWA ORDERS STUDY OF YUKON-ALASKA PORTS TRANSPORTATION ROUTES.

Ottawa - Northern Development Minister Laing has disclosed that important study is to be made by Travacon Research Ltd. of Calgary, of transportation routes between Yukon and tidewater ports in Alaska. He said study would focus on possible road linking Yukon interior with Alaskan port of Skagway, via Carcross, just north of B.C. border. It would also consider alternatives based on existing routes, such as White Pass, Yukon Railroad and Haines Cutoff Road.

Toronto papers - November 9, 1966.

IMPERIAL OIL LIMITED

PRODUCTION RESEARCH & TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT

R. H. TESKEY,
MANAGER

339—50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

November 25, 1966

Mr. K. R. Shipley
Imperial Oil Limited
Transportation and Supply Dept.
Pipeline Division
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

Re: Seminar on Strain Gauges

Thank you for your letter of November 21, regarding the seminar on strain gauges at the University of Miami.

We agree that it would be very beneficial to have someone attend this seminar, however we will not have anyone free to go during that time. We hope that you will be able to send an engineer to the course.

Yours very truly

R. H. TESKEY

By R A Hemstock
R. A. Hemstock

RAH/mt

file 662
day

IMPERIAL OIL LIMITED

November 25, 1966

Mr. K. R. Shipley
Imperial Oil Limited
Transportation and Supply Dept.
Pipeline Division
111 St. Clair Ave. W.
TORONTO, Ontario

Attention: Mr. W. J. Keys

Dear Sir:

Re: Seminar on Strain Gauges

Thank you for your letter of November 21, regarding the seminar on strain gauges at the University of Miami.

We agree that it would be very beneficial to have someone attend this seminar, however we will not have anyone free to go during that time. We hope that you will be able to send an engineer to the course.

Yours very truly

R. H. TESKEY

Copy (Original Signed) R. A. Hemstock

By____________________
R. A. Hemstock

RAH/mt

file 662
day

COPY

PL 166 (2-64)

HUMBLE PIPE LINE COMPANY
P. O. BOX 2220
HOUSTON, TEXAS 77001

November 10, 1966

Mr. W. J. Keys
111 St. Clair Avenue West
Toronto, Ontario

Dear John:

You will find this brochure on the University of Miami Strain Gage Seminar interesting.

John, we recommend that the engineer(s) that will make the actual gage installation attend this or a similar course. The course will:

- Bring the Engineer abreast of the state of the art.

- Permit them to meet the manufacturers and consultants.

- Provide an opportunity to discuss our specific problem with the experts. They could comment on our choice of instruments, gage location and installation techniques.

We are underway on the information you need and hope to have it soon.

Bill Walton

B. G. Walton

9.666E

BGW:bm

P/L DIVISION
FILE No. ~~1.150~~
NOV 14 1966

9.666.E
since involves Arctic Research Program.
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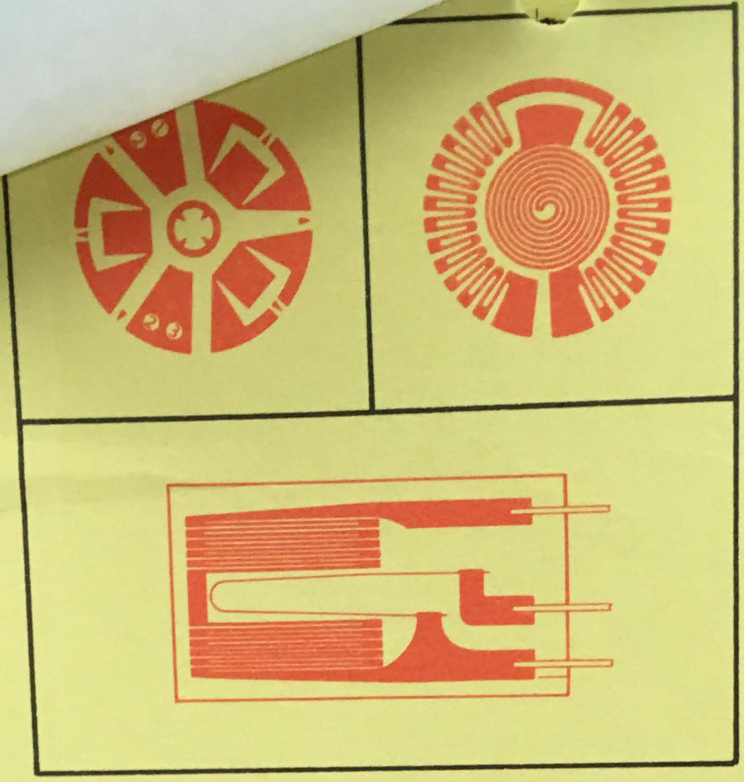

STRAIN GAGE SEMINAR

Endorsed by the Society for Experimental Stress Analysis

January 9 - 13, 1967

A352
Walton

The Mechanical Engineering Department
School of Engineering and the
Division of Continuing Education

University of Miami

Coral Gables, Florida 33124

PURPOSE

The program will present a coordinated series of lectures and lecture-demonstrations on the characteristics and uses of the wire, foil, and semiconductor piezoresistive strain gage including the associated instrumentation. The course will cover both the theoretical and practical considerations involved when using strain gages in stress analysis and transducer applications. Special attention will be paid to recent advances in strain gages, strain gage installation techniques, and the fatigue life gage.

PREREQUISITE

The program is intended primarily for those with a bachelor's degree (or higher) in engineering, physics or metallurgy. In certain cases, however, experienced technicians without degrees can be expected to gain full benefit. The nature of the strain gage is such that its use involves elements of both mechanical engineering (stress analysis and applied mechanics) and electrical engineering (electronics and instrumentation). While the material will be presented primarily from the viewpoint of the mechanical engineer to these elements, the topics have been selected to provide maximum benefit to both skilled stress analysts with little instrumentation experience and instrumentation experts unfamiliar with the various aspects of stress analysis.

COURSE CONTENT

The lectures will present the theory of the resistance strain gage in an orderly fashion, beginning with the basic characteristics of the gages themselves and progressing through the circuitry, measuring systems, and instruments involved. Interspersed between the theoretical lectures will be lectures and lecture-demonstrations dealing with industrial applications of strain gages, strain gage installation, semiconductor strain gages, and

auxiliary methods for strain me
topics to be discussed include

Basic theory of wire, foil, and
semiconductor strain gages.

Details of gage characteristic

Strain gage installation for st
and transducer applications.

Photoelastic coatings as an a

Brittle coatings as an auxiliar

Computing circuits and meas
quantities other than strain.

Electrical circuits for strain ga

Measuring systems and instru

Dynamic strain measurement.

Application of semiconductor

Strain rosette analysis and inte
of results.

The fatigue life gage.

Industrial applications of strain

The lectures will be held from
1:00 to 5:00, Monday through Fri

INSTRUCTIONAL STAFF

The program will be under the
vision of Dr. Jerome Catz, Depart
cal Engineering, University of Mi
will be presented by a distinguishe
gage specialists noted for their w
gage field and for their contribu
semination of strain gage inform
the country:

William T. Bean, Consulting Eng
Detroit, Michigan

auxiliary methods for strain measurement. Specific topics to be discussed include:

Basic theory of wire, foil, and semiconductor strain gages.

Details of gage characteristics.

Strain gage installation for stress analysis and transducer applications.

Photoelastic coatings as an auxiliary tool.

Brittle coatings as an auxiliary tool.

Computing circuits and measurements of quantities other than strain.

Electrical circuits for strain gages.

Measuring systems and instruments.

Dynamic strain measurement.

Application of semiconductor strain gages.

Strain rosette analysis and interpretation of results.

The fatigue life gage.

Industrial applications of strain gages.

The lectures will be held from 9:00 to 12:00 and 1:00 to 5:00, Monday through Friday.

INSTRUCTIONAL STAFF

The program will be under the immediate supervision of Dr. Jerome Catz, Department of Mechanical Engineering, University of Miami. The lectures will be presented by a distinguished group of strain gage specialists noted for their work in the strain gage field and for their contributions to the dissemination of strain gage information throughout the country:

William T. Bean, Consulting Engineer
Detroit, Michigan

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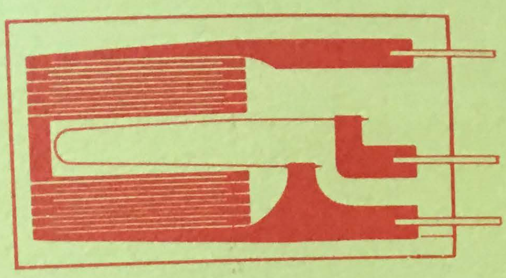

Jerome Catz, Associate Professor of Mechanical Engineering
University of Miami
Coral Gables, Florida

James Dorsey, Chief Engineer - Sensors
BLH Electronics
Waltham, Massachusetts

William M. Murray, Professor of Mechanical Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts

Joseph C. Sanchez, Vice President - Engineering
Micro-Systems Incorporated
Pasadena, California

Leon J. Weymouth, Staff Consultant
BLH Electronics
Waltham, Massachusetts

TUITION

Registrants can enroll for the Seminar by completing the attached application and returning it with a check for $200.00 to the Director of Professional Education, Division of Continuing Education, P. O. Box 8005, University of Miami, Coral Gables, Florida, 33124.

ACCOMMODATIONS

Participants will be housed at the Holiday Inn, 1350 South Dixie Highway, Coral Gables, Florida, 33146, telephone (305) 667-5614. The Inn is located adjacent to the University's Main Campus.

Room rates will be $20.00 - $24.00 single and $22.00 - $26.00 double. Upon receipt of your registration Application, we will forward a Holiday Inn reservation form. All reservations will be made directly with them.

Meals at modest student prices are available at the University's Student Union or at the Inn and a variety of restaurants in the area.

All classes will be held in Room 190 of the Learning and Instructional Resources Center (LIRC) located on the main campus.

REGISTRATION APPLICATION

SEMINAR

November 22, 1966

Messrs: R. L. Bullock - Humble Pipe Line Company
W. J. Keys - Imperial Oil Limited

Gentlemen:

The attached article entitled "Corrosion Control of Pipe Line Systems in the Far North" by Mr. R. F. O'Shaughnessy, Westcoast Transmission Company, which appeared in the November 1966 issue of Pipe Line News, is extremely interesting in view of the recent interim report on this same subject prepared by Frank Therrell.

I have not as yet reviewed this in comparison to our report, but I would suggest that if this is substantially different, that we reevaluate the points raised.

Very truly yours,

H. C. Cook

HCC:ms
Attachment

9.666.E

P/L DIVISION
FILE No. ~~1.904.6~~
NOV 24 1966

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3221.

Corrosion Control of Pipe Line Systems in the Far North

By
R. F. O'SHAUGHNESSY
Westcoast Transmission Co.
Vancouver, B. C.

Introduction

WESTCOAST Transmission Co. Ltd. is presently gathering sour, wet, acid gas in northeastern British Columbia, treating the gas, and transporting it to markets in British Columbia and the northwestern United States. Recently, we extended our transmission system 220 miles northward along the Alaska Highway to the Fort Nelson Area, where we gather sour gas and process it at our new Plant. In addition, we operate a sour gas gathering system and process plant in southwestern Alberta, where gas containing over 15% H_2S is transmitted through mountainous terrain for 50 miles to the process plant.

This report deals with the corrosion problems associated with gathering sour gas in remote areas and cathodically protecting the pipelines.

Internal Corrosion

Well fluids in most sour gas fields contain varying amounts of hydrogen sulphide (H_2S), carbon dioxide (CO_2), water and hydrocarbons or condensate. This solution of H_2S and CO_2 in the fluid forms an acid electrolyte which can attack steel. Despite the fact that hydrogen sulphide is the dominant corrosive agent, the iron sulphide produced by the corrosion reaction is a corrosion inhibitor. The iron sulphide forms a protective film which, in effect, polarizes the electro-chemical reaction that would otherwise continue at a rapid rate.

Consequently, the overall corrosivity may often be considered relatively mild. However, if anything interferes with the formation of this protective film, or causes it to break down or change after it is formed, then there can be a very severe corrosion attack.

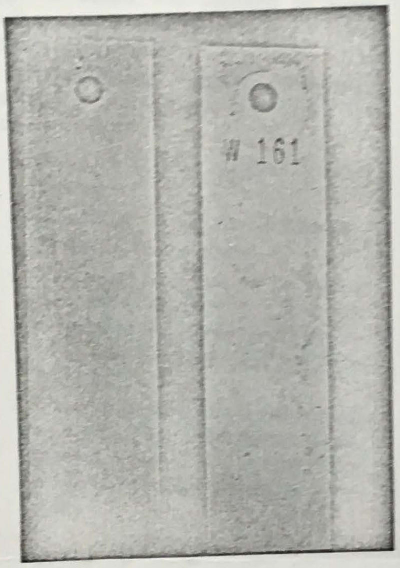

Figure 1 — Corrosion Coupons from Sour Gas Pipeline, Showing Before and After Inhibition.

There are five types of internal corrosion and metal degradation commonly found in sour gas gathering systems. These are general or uniform corrosion, pitting or highly localized corrosion, stress-corrosion cracking, hydrogen-stress cracking, and hydrogen-blistering.

General Corrosion

This is, more or less, uniform loss of metal from the total area of metal exposed to the corrosion medium, such as occurs in acid solutions. When the produced water is low in volume, general corrosion of the gathering system should be mild for the most part, largely because of the protective nature of the iron sulphide film. General corrosion in a sour gas system can be quite variable, ranging from virtually none to severe attack. It is the least troublesome and the easiest type of corrosion to combat. Unless allowed to proceed unchecked for an extended time, it will not be a problem.

Pitting Corrosion

Pitting corrosion is always dangerous in any part of the sour gas system. Pitting will usually occur when the protective iron sulphide film fails. When this happens, the exposed metal will become anodic to the surrounding area. This causes a current

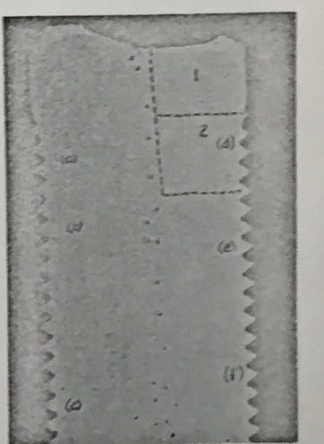

Figure 2 — Groud Half-Section of 1½-inch Bolt Showing Various Stress Corrosion Cracks.

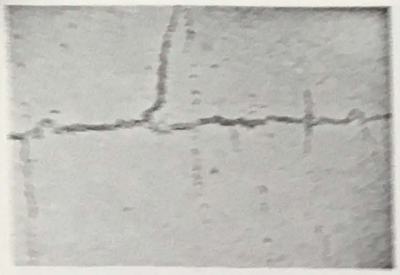

Figure 3 — Photomicrograph of Part of Crack at (4) Fig. 2. Note Branching Nature of Crack. Mag. 42X

flow in the electrochemical cell created. Accelerated local attack in the form of pits develops, which if not arrested, can perforate the walls of pipe and pressure vessels.

Stress-Corrosion Cracking

Virtually all metals and alloys can be made to fail by stress-corrosion cracking under specific sets of conditions. This is sharply localized corrosion along planes of high tensile stress. The mechanism of stress-corrosion cracking is not yet fully understood. But it has been proven that the cracking can be retarded by application of cathodic protection or by the use of an effective corrosion inhibitor. Thus, the phenomenon is basically caused by corrosion.

Steel-corrosion cracking in steel is most likely to occur in and adjacent to welds. The stress responsible for this type of attack is usually in the vicinity of the metal yield strength. It is the sum of all tensile stresses at any location and is comprised of the operating stresses of known magnitude, the internal stresses of unknown magnitude usually developed during the fabrication of equipment, and the indeterminate stresses incidental to the installation of equipment. Since the total tensile stress at any particular point in the entire system is not known, it is almost impossible to predict with certainty those areas where stress-corrosion cracking may occur. Stress-corrosion cracking sometimes develops very quickly, and even though the metal corrosion loss is very small, the damage can be catastrophic since complete cracking of the equipment involved is the ultimate result. Therefore, every reasonable means should be used to minimize the total stresses in a sour gas system.

Hydrogen-Stress Cracking

A hydrogen-stress crack is the spontaneous brittle fracturing of steel subjected simultaneously to a corrosive aqueous hydrogen sulphide medium and a static stress less than the tensile strength of the steel. The phenomenon has been called sulphide corrosion cracking, stress-corrosion cracking, and sulphide-stress cracking. However, there is substantial evidence to show that nascent or atomic hydrogen absorbed by steel under stress is responsible for the failure process, and therefore, we believe that "hydrogen-stress cracking" is the more appropriate term. Corrosion of steel by aqueous hydrogen sulphide is simply the means by which atomic hydrogen is generated. Hydrogen sulphide further contributes to the cracking phenomenon since it promotes rapid absorption of the atomic hydrogen by the steel.

Hydrogen Blistering

Hydrogen blistering is the result of atomic hydrogen penetration of the steel and the conversion of atomic hydrogen to molecular atomic hydrogen at internal discontinuities. This type of attack has resulted in some rather spectacular failures in sour gas gathering systems.

The following conditions are necessary for hydrogen blistering to occur:

1. A steel surface subject to corrosion.
2. A source of reactive hydrogen.
3. A liquid water phase.
4. An agent capable of poisoning the steel surface so that the formation of molecular hydrogen from atomic hydrogen is retarded.
5. Gross imperfections in the steel, such as slag inclusions, voids, discontinuities, or minute imperfections within single crystals.
6. A promoter which maintains an active surface.

In a sour gas pipeline, the hydrogen sulphide and carbon dioxide cause the corrosion on the inside of the pipeline, releasing atomic hydrogen. The condensed moisture in the gas or free water from the well form the liquid water phase. Hydrogen sulphide is the poisoning agent which retards the formation of molecular hydrogen and is also the promoter that maintains an active steel surface. Due to the rolling and cooling of steel plate, there is often gross imperfections and discontinuities that would allow hydrogen blisters to form.

Figure 6 — Thermo Electric Generator in Operation.

Preventive Measures

As mentioned, one of the important prerequisites for corrosion is the presence of a liquid water phase. Without free water, sour gas can be transported in steel pipelines with minimal corrosion losses. Therefore, at each well head or central gathering point, dehydration equipment is installed to maintain a dewpoint depression lower

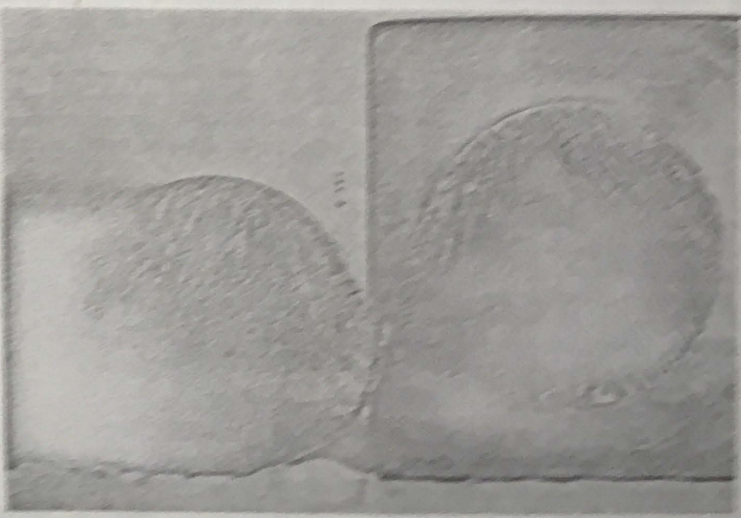

Figure 6 — Valve Stem Failure by Hydrogen-Stress Cracking.

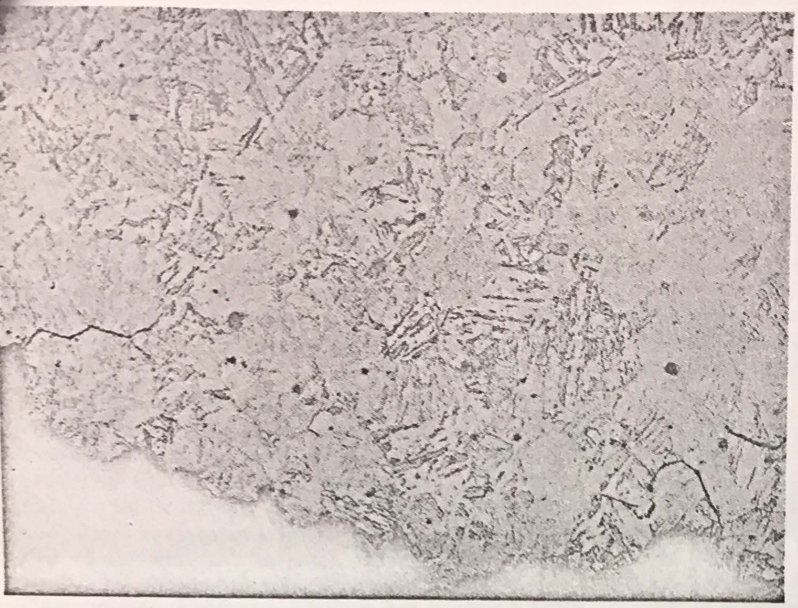

Figure 5 — Photomicrograph of Valve Stem Failure Showing Intergrannular Corrosion Cracks. Mag. 150X

than the minimum gas temperature. In sour gas fields where there are no liquid hydrocarbons (condensates), dehydrations is all the corrosion preventitive measures required, providing there is good control over the dewpoints.

However, where gathering fields contain condensates, the condensates with entrained water are separated prior to dehydration and then combined with the dry gas so that a great deal of free water is carried in the gathering lines. Where this condition exists, other corrosion control methods are required.

Westcoast Transmission Company Limited uses an organic corrosion inhibitor in all sour gas gathering lines containing condensates. This inhibitor is a complex, high molecular weight compound that adsorbs on the inner surfaces of the pipeline, forming a film several molecules thick. The film forms a barrier preventing the moisture from reaching the steel surface.

After construction of a gathering pipeline, but prior to the line being placed in service, the inside surface is precoated with inhibitor. An inhibited diesel oil (approximately 10% inhibitor) is pumped into the line behind a rubber squeegee pig. Two follow-up pigs are then placed in the scraper barrel and kicked off with gas at a pressure varying from 35 to 50 psi. Radio contact is maintained with the far end of the line and when the pigs arrive they are either blown through the trap or received in the scraper trap, depending on the location. The line is then ready for sour gas service.

Inhibitor Is Injected

In order to maintain a continuous film, it is necessary to inject inhibitor into the condensate so that there will be inhibior available to replace that lost by deadsorption. By laboratory tests and field experience, it has been found that a minimum of 50 ppm inhibitor is required in the condensate to maintain a film. In our system, this is roughly one-half pint of inhibitor per MMcfd.

Inhibitor injection equipment is installed at all sending barrels of each line and in some cases where there are additional wells tied in along the line, more injection equipment is required. Normally, installing injection pumps where there is either electricity or low pressure dry gas does not present very much of a problem. However, in our case, neither of these are available and our power source is wet, sour, high pressure gas. As the operation is being conducted in an area where winter temperatures of 50 degrees below zero are not uncommon, the injection equipment has to be installed in a heated building.

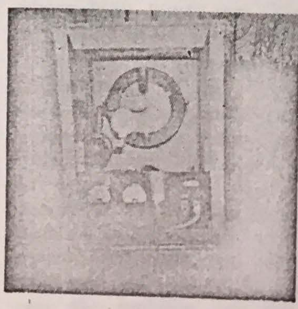

Figure 7 — Front View of 20 Watt Thermo Electric Generator.

In a standard installation, a 2-inch connection is made to the top of the gathering system line at a scraper barrel by-pass. This connection has two purposes, it is used for inhibitor injection into the pipeline, and as a source of gas to operate the pumps. This gas is brought through a 1-inch line to the pump house, and then makes one pass through an indirect heater operating at 180° F. The warm gas is then run through a Fisher type 630 regulator and the pressure reduced to 150 psi. From there, the gas goes into a volume tank, which is connected to a steam trap that automatically dumps to the flare when the liquid accumulation exceeds a predetermined level. The gas then goes through a second pressure reduction to 20 psi, passes thru a safety fuel gas scrubber and is used to power the inhibitor injection pump and fire the heater.

Inhibitor reservoirs, consisting of two 55-gallon drums, are located at each site. Large reservoirs are provided in order that injection can continue uninterrupted through the difficult spring break-up period. The equipment can then be checked periodically by helicopter without having to carry inhibitor.

In order to properly evaluate the degree of protection obtained in a sour gas system, evaluation points (which contain corrosion coupons and a hydrogen probe) are installed at the sending and receiving barrels of each line. The evaluation point at the sending end is located upstream of the injection point. A 4-inch access branch is installed on a 4-inch tee in the scraper barrel by-pass line. In this way, normal operations can be carried on with the coupons left in the line. The 4-inch branch with a gate valve gives up sufficient room to permit installation of two pair of corrosion coupons, attached to a hydrogen probe.

The corrosion coupons are changed monthly when the line is first put into operation. In this way, the effects of the inhibitor program can be evaluated quickly and accurately. After the program is established, the test period of the coupons is increased to six months and, in many cases, the probe and coupons are removed from the location upstream of the inhibitor injection.

Hydrogen Probes Are Used

Hydrogen probes, on which the corrosion coupons are attached, simulate a lamination in the steel pipe wall and indicate a generation of

atomic hydrogen. The action of the probe is to provide an annular space. free from the presence of a poisoning agent (H_2S) where the atomic hydrogen can unite to form molecular hydrogen. This results in a pressure build up within the probe which is observed on a 30-pound pressure gauge.

Once the probes and coupons are installed in the line, it then becomes necessary to have some method of gathering the hydrogen probe data, change the corrosion coupons, and also check continuously on the operation of the inhibitor injection equipment. To accomplish this, Westcoast Transmission Company Limited has one corrosion technician and one utility man operating in the Fort St. John area. Under the direction of the corrosion technician, the utility man records all hydrogen probe readings once a week, checks the chemical pumps twice a week, and records the inhibitor injected on a prepared form. This information is plotted in in the field and sent in to the corrosion engineer for evaluation.

Metallurgical Control

Because there are a reasonable number of materials which are or can be made resistant to corrosion, metallurgical control has been accepted as one of the most reliable methods of preventing failures due to corrosion. In our system, material selection and treatment are used primarily in valves and equipment to prevent failures due to stress-corrosion cracking and hydrogen-stress cracking.

One of the most spectacular failures that we have had was caused by stress-corrosion cracking in bolts (see Figs. 2 and 3). A 16-inch mainline valve carrying 15% H_2S blew up after less than two months service. A study of the failure showed that the buried valve had been leaking and H_2S had accumulated around the bolts. To prevent a re-occurrence of this type of failure, all valves were uncovered and the bolts changed to fully annealed ones with a hardness level below Brinnell 225 (Rc 22). These new bolts have been checked annually for cracks with ultrasonics and no flaws have appeared.

In general, we have adopted the "National Association of Corrosion Engineers T-1B Specification for Sour Service" in our design of equipment, and this has proven very satisfactory.

Cathodic Protection

As is the case in most natural gas transmission companies, Westcoast coats, wraps, and cathodically protects all underground piping. We have found that the impressed current system of cathodic protection is the most economical because of the few installations required and the relatively low costs of operation. However, as the system grows northward, accessibility becomes difficult and there is little or no power available for the rectifiers.

The small, remote, unattended generating stations have not proven too reliable as a continuous source of power for cathodic protection. In one location, we have three small generators in parallel, so that there is always one generator out for repairs and a spare available as standby. The cost of maintenance for the 2 amps. required at this location is $3,000 annually. Because of these high maintenance costs, we are experimenting with thermo electric generators in remote areas.

Thermo Electric Generators

The voltage of the generator can be adjusted by increasing or decreasing the fuel pressure to the combustion chamber. There is a time lag of approximately one-half hour while the temperature gradient of the generator finds a new level. We have found in practice that the output cannot be varied too greatly with the change in fuel consumption so that the system should be designed more carefully than the normal rectifier-anode bed system. Resistors and voltage converters can be added to the system for more flexibility.

Our first thermo electric generator was installed approximately 18 months ago and has been operating continuously since that time. There has been no noticeable change in output even though the atmospheric temperature has varied from 90° F. in the summer to —40° F. in the winter. It is located in the mountains where high winds are common and we have had no flame-outs as yet.

Because the generator is inaccessible for much of the winter time, we have installed a permanent indicating voltmeter at an accessible location. This voltmeter is checked bi-monthly to ensure that the thermo electric generator is working and that the pipeline is cathodically protected. On several occasions, the voltmeter has indicated low potentials but in each case the problem was not the generator although this was the first place we looked for trouble.

Disadvantages

There are several disadvantages of the thermo electric generator — the most important being the low output. Although the rated output of a single unit is now as high as 50 watts, it was only a short while ago that 8 watts was maximum. If this trend continues, then these units will become more popular.

To increase the output of a thermo electric generator system, the following can be done:

1. Use scrap steel or high-silicon anodes instead of graphite to reduce the back EMF.
2. Reduce the ground bed resistance by using heavier wire and more anodes.
3. Put several generators in series or install a converter to increase the voltage.
4. Choose low resistance soil to install anodes as the location does not depend on availability of power or accessibility.

Another disadvantage is the high initial cost — approximately $2,000 for 50 watts. In comparison to a 50 watt rectifier, which would cost $200, this would appear high, but if power lines have to be extended some distance or motor generators have to be maintained, then a thermo electric generator becomes economical. A feature of the unit is the low operating costs. We have measured the fuel consumption of our 20 watt unit and estimate the fuel costs at 3-5 cents per month. This, in itself, would not justify an installation providing power for a rectifier were available. The economics will depend a great deal on the life of a unit, and this is still an unknown. Five years is considered a minimum and some manufacturers expect ten years. However, where pipelines are being laid in remote locations such as our own, we feel that the higher capital costs are justified and the reliability of the thermo electric generator is good.

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* Paper presented at 1966 Transmission Conference, Pacific Coast Gas Association, April 1966.

Fiberglas Pipe Price Cut

An average 5% reduction in the cost of threaded line pipe and light, medium, medium heavy and heavy service pipe and tubing has been announced by Rock Island Oil and Refining Co., Inc., Wichita, Kans., according to V. F. Michael, manager of the company's Fiber Glass Pipe Division.

Michael listed more effective and efficient production methods and greater product demand as the reasons for the price cut.

November 22, 1966

Re: PLR #482 - Arctic Research, Welding
- and Corrosion

File: 9.666E

Mr. R.L. Bullock
Planning and Development Department
Humble Pipe Line Company
P.O. Box 2200
Houston, Texas, 77001

Dear Sir:

We wish to thank you for your report "Arctic Pipeline Design and Construction - Welding and Corrosion" attached to copy of letter to Mr. H.C. Cook of November 2, 1966.

This has been discussed with Mr. Cook and agreed that it would be better to have all Arctic information in the one report. Therefore, this report will be incorporated into the overall interim report on the project. Essentially, it is planned to use it largely "as is" though some editing may be desirable to fit it into the overall format.

Rainbow Pipe Line, in which Imperial holds a one-third interest, have recently let a contract to construct a fifty mile, twenty inch diameter pipe line extension from the north end of their present system in the Rainbow Lake area of northern Alberta to a point in a field near Bistcho Lake just south of the North-West Territories - Alberta border. This work will be done in late 1966 and early 1967. It is felt this would provide an opportunity for your men to see cold weather pipeline construction, particularly the welding phase, in progress. If you are interested we will be pleased to make the necessary arrangements and keep you advised re the timing on this work. It is hoped that your own personnel may be able to visit this spread also.

Yours very truly,

K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.
cc. Mr. H.C. Cook.

November 22, 1966

Re: Seminar - Strain Gauges

File: 9.666E

Mr. R.L. Bullock
Planning and Development Department
Humble Pipe Line Company
P.O. Box 2200
Houston, Texas, 77001

Attention Mr. B.G. Walton

Dear Bill:

We wish to thank you for your letter of November 10, 1966 and attached brochure on the Strain Gauge Seminar. This looks like a very thorough treatment of the subject and it is expected we will have one person attend this cause. The information has been forwarded to Alex Hemstock since it was felt he may wish to select one of his staff for this training.

We will let you know what our final decision is in this regard and who will be attending.

Yours very truly,

K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.

November 22, 1966

File: 9.666E

Mr. R.H. Teskey,
Imperial Oil Limited
339 50th Avenue S.E.
Western Region Producing Dept.
Calgary, Alberta

<u>Attention Mr. R.A. Hemstock</u>

Dear Alex:

In connection with the pipe stress work, we mentioned at the meeting held on October 31, 1966 that we had ordered a copy of the book Bill Walton recommended, namely "The Strain Gauge Primer".

If Glem or any of your staff working on this have need to read this, and if it is not readily available, we will be pleased to lend this copy, just received, to you.

Yours very truly,

K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.

November 21, 1966

<u>Re: Seminar on Strain Gauges</u>

File: 9.666E

Mr. R.H. Teskey'
Imperial Oil Limited
Western Region Producing Dept.,
339 50th Avenue, S.E.
Calgary, Alberta.

<u>Attention Mr. R.A. Hemstock.</u>

Dear Sir:

Attached hereto is a copy of a pamphlet forwarded to this office by Bill Walton, covering a coming, one-week seminar on Strain Gauges at the University of Miami. Also enclosed is a copy of Mr. Walton's letter wherein he outlines the expected benefits re the Arctic research work on pipe stresses.

We have not forwarded any registration as yet although it is felt that it would be very beneficial to have someone attend this, probably from your engineering or technical staff. However, if they are not available, someone from our engineering staff could attend.

Please look over the attached and call the writer to review enrollment in this course.

Yours very truly,

K.R. Shipley,

By:______________________________
W.J. Keys.

WJK/EG.
Encl.

November 16, 1966.

Re: Test Installation - Arctic Pipe Line
Project # 483
File: 9.666E

Mr. R.H. Teskey,
Imperial Oil Limited,
Western Region, Producing Dept.
339 50th Avenue S.E.
Calgary, Alberta

Attention Mr. R.A. Hemstock

Dear Sir:

Further to the meeting held in Calgary on October 31 and the minutes issued November 11, 1966, we are advised that pipe is readily available from stock in Regina at Ipsco mill. We specifically inquired re. 6" 0.125" wall, Grade B and X-42 which are in stock. However, they have other wall thicknesses in this size and also other sizes such as 4" and 8" should we need to consider these.

Although we have not finalized plans, the 6", 0.125" wall appears to offer a reasonable selection which we should consider for "scale-up" test purposes regarding smallest practicable size and minimum wall in regular commercial grade pipe.

Due to the assurance of the pipe mill that our nominal requirement can be readily met we have not taken any furhter actikn in this regard.

Yours very truly,
K.R. Shipley,

By:____________________
W.J. Keys.

WJK/EG.

cc. Mr. H.C. Cook, New York
Mr. R.L. Bullock, Humble, Houston.

November 15, 1966

<u>Re: Arctic Pipeline Study, Project #48</u>

File: 9.666E

Mr. F.A. Therrell,
Humble Pipeline Company,
P.O. Box 2200,
Houston, Texas, 77001.

Dear Frank:

We wish to thank you for your letter of November 1, 1966 and attached pipe and soil temperature data for the installation near Fairbanks. This will add to the data on hand in this regard.

By copy of this letter to Mr. R.A. Hemstock, we request that he advise you directly on the pipe and soil temperature test data at the Gulkana location.

Yours very truly,

K.R. Shipley,

By:____________________________
W.J. Keys.

WJK/EG.

cc. Mr. R.A. Hemstock.

November 11, 1966

Re: Minutes of Arctic Pipeline Research Meeting

File: 9.666E

Mr. R.H. Teskey
Imperial Oil Limited
Western Region Producing Dept.
339 50th Street S.E.,
Calgary, Alberta

Dear Sir:

We have attached heteto, minutes of the meeting held in your office in Calgary on October 31, 1966.

These minutes have been divided into sections A, B and C covering respectively, Rheology of Crude Oils at Low Temperatures, Oil and Pipe Temperatures and Pipeline Stresses.

Sections A and B have been prepared from notes supplied by Messrs. McCartney and Hemstock. In case there is any error in the way these notes have been interpreted it is requested that the writers do not hesitate to advise us so that a revision can be issued.

The work load responsibility regarding the pipe stress analysis has been outlined as per the Writer's understanding at the meeting. Should there be any question or conflict here, please advise.

Yours very truly,
K.R. Shipley,

By:____________________
J.W. Keys.

JWK/EG.

cc. Messrs. R.A. Hemstock, B.C. McCartney, G. Mainlander, W. Scrimes, B.G. McKenzie, H.C. Cook (2), E.W. Christian, B.G. Walton, C. Carlisle.

Note: Notes used by Brian McCartney for meeting @ Calgary on Oct. 31/66 WJK

NOV. 11/66

File 9.666E

IMPERIAL OIL LIMITED

SUBJECT Arctic Pipeline Project

PAGE

DATE

BY

Primary Objective to develop equipment + techniques to measure flow behaviour of crude oils
- particularly Arctic Oils
- need low temperatures

Work so far designed to ultimately answer
- what will the pressure drop be at 10,000 B/D in a 12" line at 29°F.
- what difficulty will there be in starting up a line after the crude has cooled in it.

Depends on the complexity of the crude
- Newtonian
- Non-newtonian
- Non-newtonian with wax precipitation

Newtonian
- flow behaviour completely defined by viscosity vs temperature curve
- start up conditions also defined - no yield
- transient effect short - not concerned.

Non-Newtonian
- by definition viscosity not single-valued function of temperature
- depends on shear-rate and history of shear.
- need much more information in order to predict pressure drop.
- may also have a yield strength
- means start up pressure may be hard to predict and may be high

Non-Newtonian with waxy
- almost anything may happen
- waxy may only change dimension
- fatal to lab determination
- may need large scale equipment
- thermal ~~stratifying~~ also important - ie the rate of change of T when wax is precipitating

Form No. 1727

Schematic of Equipment - drawing.

- measure the pressure drop of the oil flowing at a known rate through a capillary of known dimensions at a ~~known~~ constant temperature
- the capillary used - 0.04 glass to 0.125" stainless
- ΔP measured by differential transducer + recorded
- calming section - 350 cm of 0.09" tubing
- gives some uniformity of shear history
- flow rate established by injecting Hg into the closed system
- all in a glycol-water bath - 30-40 gal.

Shear Stress - Shear Rate diagram

- Shear stress - dyne/cm^2 = $1436\, P\left(\frac{D}{L}\right)$
- Shear rate - (sec)$^{-1}$ = $47.08\, Q/D^3$
- In this type of diagram a Newton fluid is st line through the origin so -
- 50°F isotherm show a classic pseudoplastic fluid
- slope decreases with increase shear rate and goes through the origin
- the 40°F + 30°F also show pseudoplastic behavior but some doubt about the shear stress at zero shear rate which is the yield strength. (see later)

Pressure Drop Prediction.

- to go back to the question we are trying to answer - the diagram allows us to predict the pressure drop in any pipe - at any rate and temperature within the range measured.
- does not measure the thixotropic effect that is the change of viscosity with time.
- this is only important during start-up
- the thixotropic effect quickly disappears and the flowing ΔP should the one predicted from the graph.

IMPERIAL OIL LIMITED

SUBJECT ______ PAGE ______ DATE ______ BY ______

Start-up Pressure.

- much more difficult to predict than flowing ΔP.
- depends on yield strength, thixotropic effect, dimensions, compressibility of the oil, void spaces in the line, rate at which you input energy.
- if we knew enough about the system it might be possible to predict the transient pressure behaviour on start ups with a computer model.
- but we need much more basic information.
- the approach we are using now is to isolate a sample of oil
- ~~flowing~~ initial strenght vs flowing strength.
- points at zero shear rate on diagram are flowing yields.

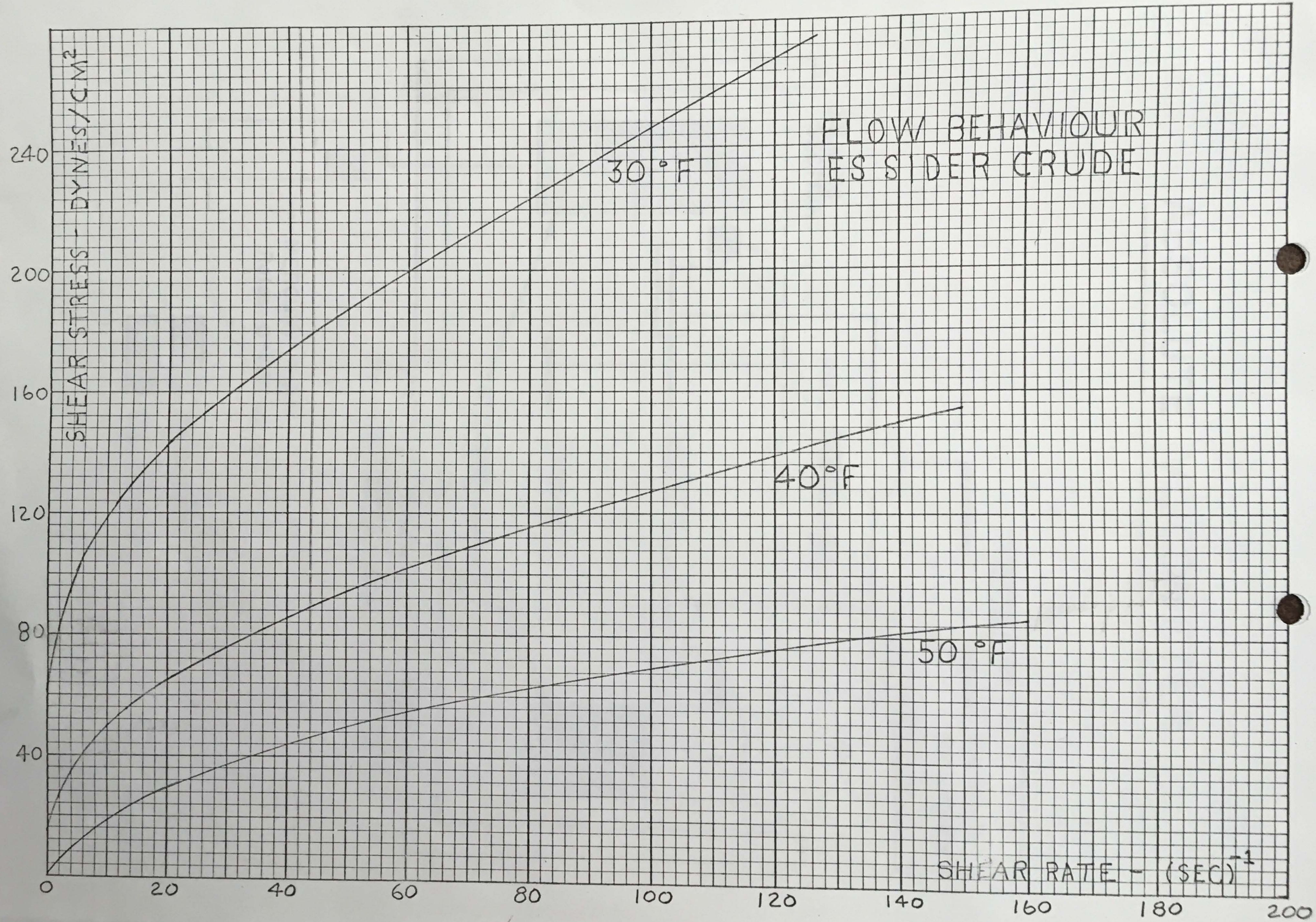
- how do you predict start-up pressure
- ΔP calculated from initial yield may ~~would~~ be the ΔP required to start the pipe line all at the same time so it would be the maximum
- but it might be many times the actual required ΔP because the pipeline doesnt start up all at the same time.
- plan to investigate effect of (L/D) on initial yield strength
- this may involve larger scale equipment than we have now and we are gathering information on suitable equipment.

Future plans

- the two unresolved problems
- how to measure fluid flow behavior in the presence of precipitating waxes + what to do about it (thermal treating)
- to measure the effect of L/D on yield strenght and see if we can use this information to predict y.s.

Form No. 1737

G8-5D
10 X 10 TO THE INCH
MADE IN CANADA
MICROGRAPH



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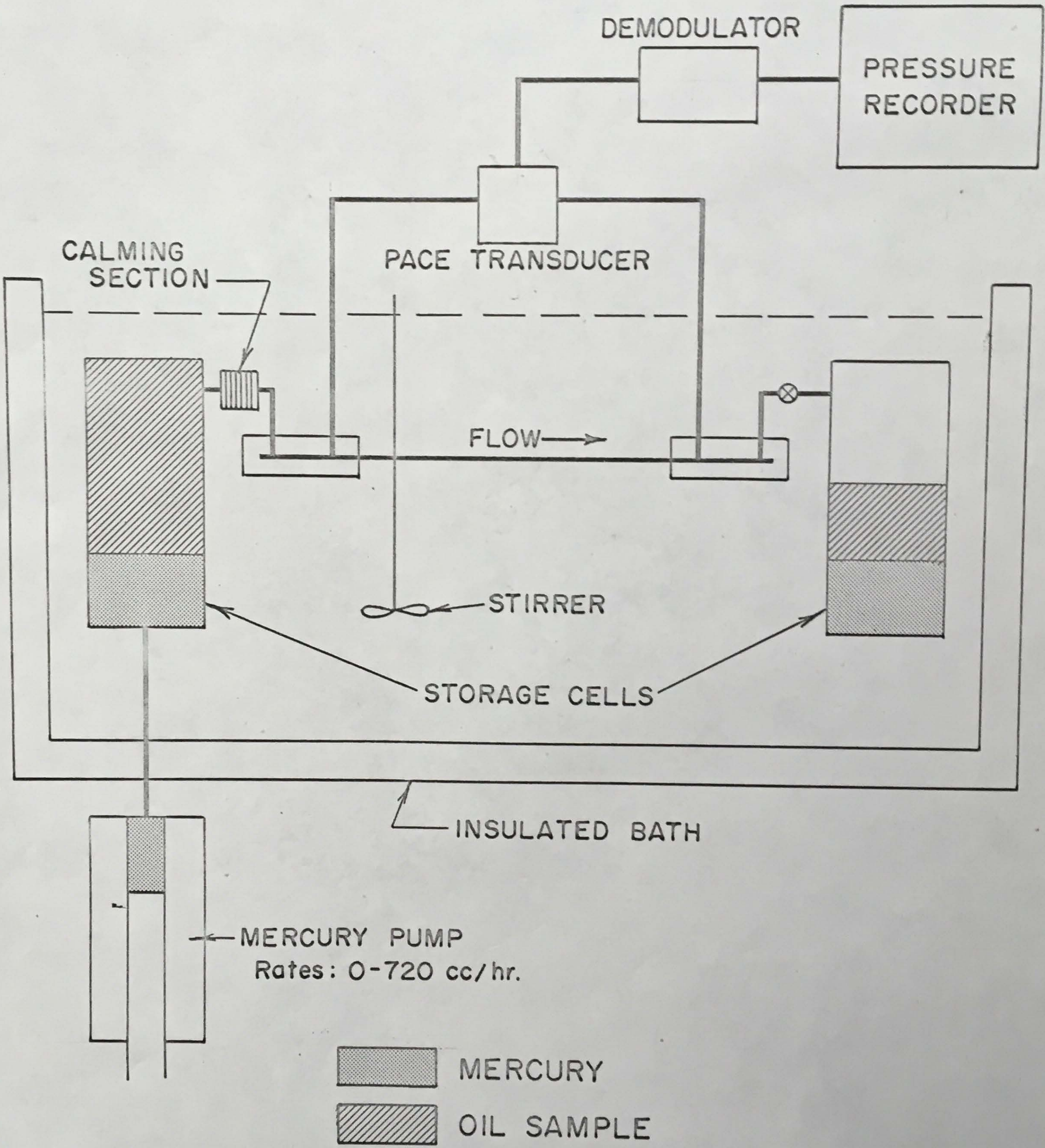

HUMBLE PIPE LINE COMPANY
P. O. Box 2220
HOUSTON, TEXAS 77001

TECHNICAL SERVICES DEPARTMENT
GEORGE G. HUGHES, JR.
MANAGER
A.V. CARDIN
ENGINEERING COORDINATOR
J. E. BARBEE
COMMUNICATIONS COORDINATOR
ROBERT L. BULLOCK
RESEARCH COORDINATOR

November 2, 1966

7.8.3 PLR Final Reports
Comments and Approval

Report No. PLR-F-99-66

Mr. H. C. Cook
Standard Oil Company (NJ)
30 Rockefeller Plaza
New York, New York 10020

Dear Mr. Cook:

The following PLR Final Reports have been completed and are submitted to you for comments and approval to print and distribute to PLR program members:

PIPELINE DESIGN AND CONSTRUCTION

WELDING AND CORROSION

1. PLR #012, PLR-S-91-66, "External Pipeline Coatings"

2. PLR #462, PLR-F-98-66, "Internal Pipeline Coatings"

3. PLR #482, PLR-F-99-66, "Arctic--Welding and Corrosion"

We are also sending by this letter a copy of the Arctic report to Mr. W. J. Keys. It may be that Imperial will want to include the information as part of Imperial's Arctic report in which case we will send the original to Mr. Keys. We believe it would be better to have all the Arctic information in one report instead of having two sources of reports. Perhaps you and Mr. Keys can discuss this before commenting. We will be happy to comply with the decision. || WSK

Your comments and approval will be appreciated. ||

Yours very truly,

Original Signed:
ROBT. L. BULLOCK

P/L DIVISION
FILE No. 9.666 E
NOV 7 1966

	NOTE	ACT	INITIAL
KRS			
CC	✓		CC.
OMK			
PAP			
LDA			
GMB			
CJB			
RDC			
CVH			
WJK	✓		WJK
DATE ANSWD	3099		

RLB:tms
Attachments

cc: Mr. W. J. Keys w/attachment
Central Records

RESEARCH SECTION
TECHNICAL SERVICES DEPARTMENT
HUMBLE PIPE LINE COMPANY
HOUSTON, TEXAS

Report No. PLR-F-99-66

ARCTIC PIPELINE DESIGN AND CONSTRUCTION

WELDING AND CORROSION

RESEARCH SECTION

TECHNICAL SERVICES DEPARTMENT

HUMBLE PIPE LINE COMPANY
HOUSTON, TEXAS

Report No. PLR-F-99-66

ARCTIC PIPELINE DESIGN AND CONSTRUCTION

WELDING AND CORROSION

FOREWORD

This is an interim report on PLR Project 482, "Arctic Pipeline Design and Construction, Welding and Corrosion," and covers the work assigned to Humble Pipe Line Company by Imperial Oil as part of the Pipe Line Research Program conducted and coordinated by Esso Research and Engineering Company under the terms of its Pipe Line Research Agreement with affiliated companies of the Standard Oil Company (NJ).

ABSTRACT

This report discusses the welding of pipelines in the Arctic region during extreme winter weather and the corrosive environment found there in relation to pipelining. Recommendations are presented for conducting pipeline welding under Arctic winter conditions and for controlling aboveground and underground corrosion in the Arctic region.

Distributed By

PIPE LINE RESEARCH

TRANSPORTATION COORDINATION

STANDARD OIL COMPANY (NJ)

DECEMBER 1966

ARCTIC PIPELINE DESIGN AND CONSTRUCTION

WELDING AND CORROSION

Interim Report of Work Done by

HUMBLE PIPE LINE COMPANY

F. A. Therrell
Author

The purpose of this project is to investigate winter welding problems and corrosion problems that exist in the Arctic region and to present recommendations for welding procedures and corrosion control measures to overcome these problems.

CONCLUSIONS

Low temperature winter welding presents three problem areas no matter whether the welding is being done in the Temperate, Sub-Arctic or Arctic regions. The severity of these problems may vary somewhat depending on the geographic location but not to the degree commonly thought of, as will be pointed out in the discussion. The specific problem areas deal with human, mechanical and metallurgical factors. With proper attention and precaution directed to these factors, there seems to be no lower limit to the ambient temperature at which satisfactory welding can be performed.

Corrosion experience is more directly related to geographic location over land masses in relationship to temperature and humidity. In this respect, atmospheric corrosion has less bearing than underground corrosion. For example, atmospheric corrosion is quite low in desert areas and decreases appreciably as one goes inland from coastal areas into areas of drier and colder climates. This condition exists throughout the Arctic region and very minor atmospheric corrosion is encountered. Long term protection can be obtained by the use of low cost coating systems such as an alkyd base paint.

Underground corrosion, however, decreases only slightly as the colder regions are encountered up to the permafrost line. Permafrost being permanently frozen land mass. Experience and experimentation have shown that virtually no corrosion is found on metal structures located in permafrost. For this reason, as well as stable mechanical and thermal forces acting on the pipeline, it would appear that the best location of a line would be in permafrost wherever possible. In unfrozen soil and climafrost, soils alternately frozen and thawed, corrosion forces would have to be countered by using a pipe coating and cathodic protection.

DISCUSSION

A literature search and personal interviews with construction and operation personnel of Sub-Arctic and Arctic pipelines were made to investigate the problems of low ambient temperature welding. Both sources indicate that when proper precautions are taken, welding can be carried out at very low ambient temperatures. These precautions cover man, machinery and metallurgical factors. The documented low temperatures range down to -52°F for manual welding and -80°F for machine welding.

Much study and investigation have been done on the physical and psychological effect of cold on man. This work has shown that man's productiveness is adversely affected by extended exposure to low temperatures. For example, the sense of touch is reduced and the sense of sight must step in to assist man in normal hand operations. When man's sight is impaired under such conditions, as it is under a welder's hood, his dexterity and sureness of hand suffer. Further study along this line, however, shows that man can be properly clothed, sheltered and worked on a schedule that will allow quality work in these low temperature ranges. Training of the worker to live and work in the Arctic environment puts him in a frame of mind to cope with the cold and to get on with the job. Information along this line is available from several sources. One of the better booklets published was done by the Defense Research Board, Department of National Defense, Canada, as a guide for men working on D.E.W. line construction.

The low temperature limit set in some welding codes appears to be based on the idea of welder comfort and its effect on welding quality. This concept has some validity and emphasizes the reason for providing welder comfort as well as looking after the other people on the construction crew. It has been more or less industry practice, particularly drilling, to shut down outside work when the ambient temperature gets down to -55°F. Assuming that proper provisions are made for the human element, it is reasonable to say that welding can also be done at this temperature.

Interestingly enough, this -55°F temperature range is just as applicable to the northern part of the United States as it is to Canada or Alaska or even the North Pole. Numerous points in the U. S. repeatedly experience lower temperatures than the normal low of -55°F recorded at the North Pole. Of course, the extended period of cold is much longer as you go north; however, the coldest temperature recorded on the North American Continent was registered as -83°F at Snag, Yukon Territory. This location is several hundred miles below the Arctic Circle.

Ground temperature and ambient temperature data have been collected at a number of locations in the general vicinity of a proposed Alaskan pipeline route from the northern slope of the Brooks Range south to tidewater. These reports indicate a normal low ambient temperature range of -20°F to -40°F.

Wind affects welding no matter what the temperature is and most welding codes have a clause covering this. As the temperature drops, wind has an increasingly important effect on man and is referred to as chill factor. This simply means that at a given ambient temperature, a man exposed to wind will experience a lower relative temperature and this temperature level will decrease as

as the wind force increases. Therefore, it is evident that some form of shelter is required to protect man under windy conditions as well as to allow stable conditions for the welding process. The next step beyond this would be to heat the shelters whenever the combination of wind and temperature reached the point that affected welding quality. Fortunately, much of the area under immediate attention does not normally experience wind velocities over seven miles per hour during the winter months.

Machinery and equipment are also affected by low temperatures. Military and industrial activity in the Arctic region has done much to reveal the precautions necessary to work in this environment. This discussion will be limited to that machinery and equipment associated with welding although the winterizing program is applicable to practically everything on a construction spread.

Welding machines need to be in top condition on any job and this is even more imperative in the remote Arctic region. A good maintenance program is a must including heated working shelter for the mechanics. It has been found that engines are better off to run constantly unless heated shelter is available. Of course, low temperature lube oils and greases are required for trouble-free lubrication. Bronze bearings or equivalent should be changed to steel roller bearings to prevent binding at the low temperatures. Cable leads require a suitable low temperature insulation that will provide adequate flexing. This problem can also be approached from the standpoint that increased electrical conductivity of the cable leads at the lower temperatures allows the use of smaller cable than that normally used at higher ambient temperatures. Acetylene cylinders are greatly affected by low temperatures. Heated storage of the cylinders should be provided equal to the charging temperature. Electrodes are best stored in unheated shelters or in cabinets with controlled humidity. Welding hoods and hand shields are also best stored in unheated shelters. Some operators prefer the hand shield for winter welding due to the head band adjustment over bulky head gear and the frosting over of the lens from the breath. These problems stated above are by no means all to be considered in low ambient temperature welding but should suffice as a guide for consideration in Arctic work.

The third factor to consider in Arctic winter welding deals with the metallurgical soundness of the weld. Laboratory tests and field experience have shown that low ambient temperature welding is influenced almost entirely by the increased rate of cooling resulting from the lowered temperature condition. From these same sources it has been found that a general solution to this problem is to increase the over-all heat input to the welded joint to slow down the cooling rate. A widely used guide for this increased heat input amounts from 5 to 8% for every 18°F drop in ambient temperature below the normal ambient.

A number of ways are available to realize this increased heat input. Preheating is probably the most common method used. Increasing electrode size or the welding current, or decreasing the travel speed are other methods that can be used. Another widely accepted method is the use of low-hydrogen electrodes. Tests and experience have shown that fewer failures occur in the heat affected zone with the use of the low-hydrogen electrodes. Some codes and specifications require that a weld be completed within a given time once it is started. Blanketing a weld with an insulating material has also been used

with good success. Combinations of these methods have also been used to realize the desired results of controlling the cooling rate.

Therefore, it can be seen that incomplete preparation of men and/or machinery and inattention to the complete welding process can affect welding production and quality. These matters must be realized and adequately dealt with for a successful welding program in low ambient temperatures. When this is done, the temperature limit for Arctic welding will be related to the suitability of the working conditions and welding procedure that are provided.

Corrosion problems in the Arctic region are found to be minor. Besides making a literature search on this subject, a field trip was made to investigate actual conditions in the western portion of the Northwest Territory, the Yukon Territory and a good portion of Alaska. See Figure 1 for the area covered plus the location of points from which temperature data reports have been obtained. Similar temperature data is being collected by Imperial Oil in the Canadian Territories.

Atmospheric corrosion was found to be very minor throughout the entire area investigated. Many bare iron and steel structures along the open sea at Tuktoyaktuk, Barrow, Nome and Kenai Peninsula showed little evidence of any atmospheric corrosion. Of course, under these conditions, coated structures were in excellent condition.

Experience on underground corrosion in the Arctic region was found to be rather limited. Outside of the general coastal areas of Skagway, Haines, Anchorage and Nome, the only buried lines found were at Norman Wells, Dawson City, Whitehorse and Fairbanks. Corrosion on the lines witnessed at these locations was slight to moderate. The oldest buried line investigated was a 48-inch water siphon line that was installed in 1903 near Dawson City, Yukon Territory. Although this line has been out of service for many years, there is still very little corrosion. The only evidence witnessed of severe corrosion resulting in a leak was on some pipe removed from a muskeg area near Haines on the military products line built from there to Fairbanks in 1956. Pipe replaced through this area was coated with a plastic tape and anodes were scheduled to be installed for cathodic protection. A number of aboveground lines were inspected that dated from 1942 back to the early or mid-1920's with no record of a corrosion leak.

In the areas further north from the immediate coastal areas of southern Alaska, the permafrost is generally found within a few inches of the ground surface, particularly where the ground cover is not disturbed. Considerable research investigation with piling in permafrost has been conducted by the Arctic Field Station just outside of Fairbanks, Alaska. This is in conjunction with the U. S. Army Cold Regions Research and Engineering Laboratory, Corps of Engineers, Hanover, New Hampshire. Their investigations have shown no corrosion on steel piling in the permafrost zone. This experience prompts us to consider laying a line in permafrost or in such a manner as to promote the formation of permafrost around the line. The evidence of corrosion in the climafrost area would dictate that coating and cathodic protection be used on buried lines in these areas. Although the evidence does not demand coating lines aboveground, it may be beneficial to use a white or aluminum coating on such lines to help reduce thermal movement.

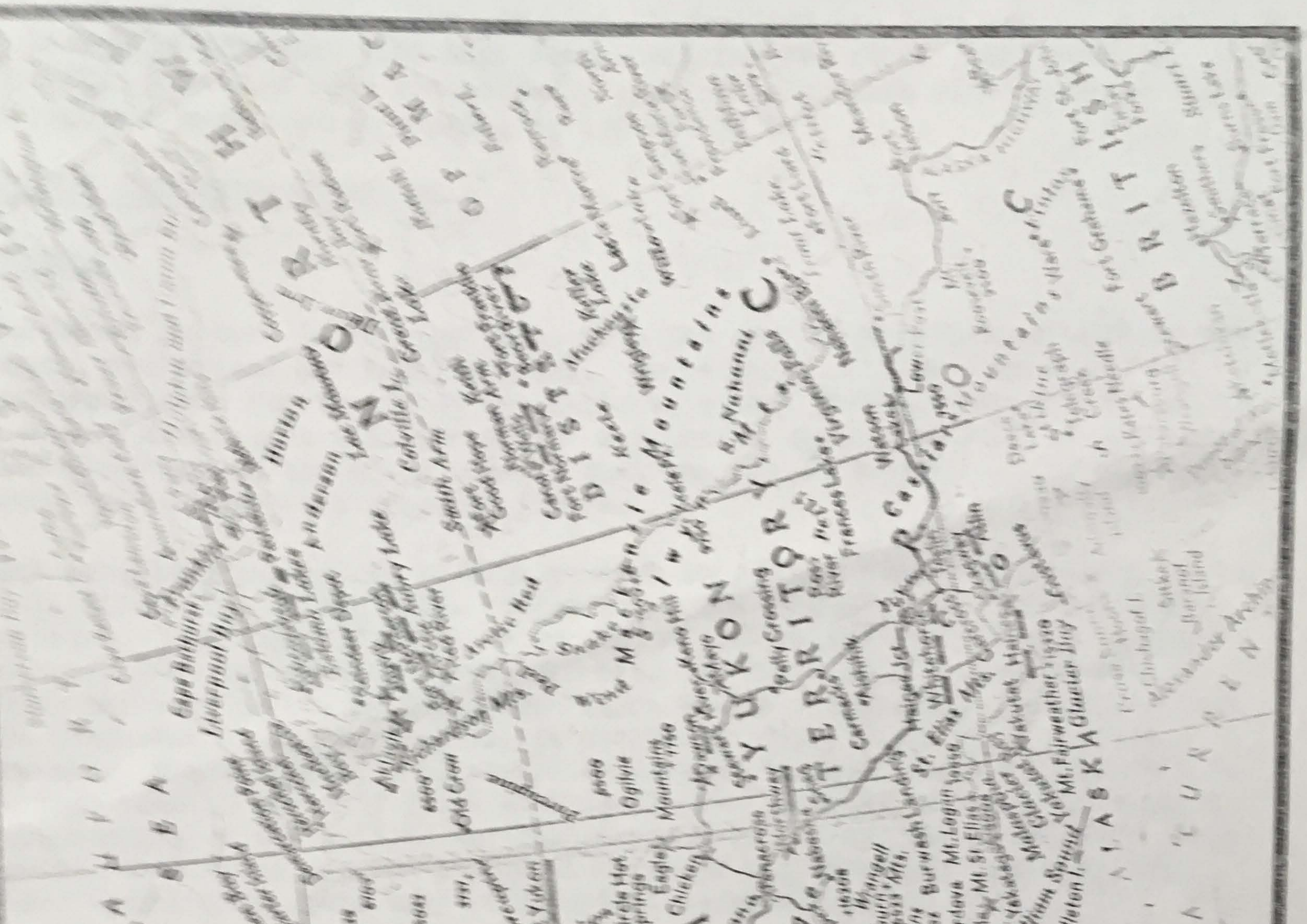

Figure 1 Arctic Region Investigated. Broken lines show locations investigated for corrosion. Solid lines show temperature data locations.

Two coating systems are known to have performed well in low ambient temperature construction work. Yard-applied X-Tru-Coat has been used on pipe up to 20 inches in diameter with tape being used for the field joint coating. Plicoflex tape has been successfully applied to 20-inch pipe over-the-ditch at ambient temperatures ranging as low as -30°F.

SUMMARY AND RECOMMENDATIONS

Welding

The three factors to be considered with low ambient temperature welding are human, mechanical and metallurgical. We can make more or less a general recommendation for the first two factors in that they must be winterized to a degree consistent with the Arctic weather to which they will be exposed. One advantage on the human side is that man can be taught to live and cope with the weather when properly provided.

The metallurgical aspect of this problem is almost totally influenced by the rate of cooling of the weld. Three steps are suggested to overcome this problem. The first of these is to preheat the entire weld area to a point specified by the welding inspector or as set forth in the specifications. This may vary as the ambient temperature varies. Secondly, the weld should be completed in as short a time as practical after it has been started. Finally, the completed weld should be covered securely at least one foot to either side of the weld joint with insulating material adequate to control the cooling of the weld to the satisfaction of the welding inspector. As a guide, this would require a time interval of approximately one hour, but here again, this could vary with ambient temperature.

An additional step that could be taken as a part of the welding specification would be to specify the use of low-hydrogen electrodes such as the E-7016. An additional step that must be taken in the event that wind or temperature or combination of both, creates unsatisfactory welding conditions is the sheltering of the welding stations. This may also require heated shelters in extreme cases.

No shut down temperature is specified as related to the welding phase of the work. This decision will have to rest with the welding inspector based on the performance of the welders and the resulting finished welds.

Corrosion Control

Atmospheric corrosion is very minor in the Arctic region. Tanks, machinery, fittings, manifold piping and other aboveground piping need not be coated except for appearance and good housekeeping operations. Machinery, fittings, and prefabbed manifold piping would be recommended shipped with a shop-applied oil base alkyd primer. The finish coat on this equipment and material as well as the complete painting of tanks and other aboveground piping could be done the first summer season that it would be convenient to do so.

Pipe buried in unfrozen soil or the climafrost zone should be coated with X-Tru-Coat or Plicoflex tape or some similar tape system requiring a primer. The specific selection should rest on the economics of the different systems.

Neither asphalt nor coal tar enamel type coatings are recommended in this environment.

Pipe buried in permafrost, or in such a manner that permafrost will form around the pipe, need not be coated. However, if the operation of the line required heating of the product, then a coating would be required throughout. In this case the use of polyurethane foam should be considered in the overall economics of investment and operating cost.

Esso

IMPERIAL OIL LIMITED

PRODUCTION RESEARCH & TECHNICAL SERVICE LABORATORY
WESTERN REGION PRODUCING DEPARTMENT

R. H. TESKEY,
MANAGER

339—50TH AVENUE SOUTH EAST, CALGARY, ALBERTA

November 1, 1966.

Mr. K. R. Shipley,
Imperial Oil Limited,
Transportation & Supply Dept.,
111 St. Clair Avenue West,
Toronto, Ontario.

Attention: W. J. Keys

Dear Sir:

We are enclosing a copy of the paper used as a reference at our meeting on Monday. We trust that you will be able to abstract the important points for your minutes.

Yours very truly,

R. H. TESKEY

By: [signature]
R. A. Hemstock

RAH/co
encl.

File 662

Incorporated attached into minutes
WJK

P/L DIVISION
FILE No. 9.666E
NOV 3 1966

	NOTE	ACT	INITIAL
KRS	✓		KLS
CC	✓		CC
DMK			
RAP			
LDA			
EMB			
CJB			
RDC			
CVH			
WJK	✓		WJK
DATE ANS'D	3072'		

ARCTIC PIPELINE DESIGN

Finding oil in the western Arctic will only be an economic success if the oil can be moved to market and sold at a profit. Since the Arctic coast is ice-blocked for most of the year the only way to get oil to market is by a major pipeline to Pacific tidewater, probably in the Haines-Alaska area.

Major crude oil lines have not been built in Arctic areas of North America. Crude oil and gas lines have been installed at these latitudes in Russia but we have little information on their technology.

There are two main problem areas as we see it. First--will the oil flow at pipeline temperatures; and secondly, how do we design a major pipeline system through permafrost, muskeg and delta terrain and in the Arctic climate.

Brian McCartney is in charge of a group working on the low temperature rheology of crudes. Hopefully, we will soon be in a position to measure the low temperature characteristics of the crude oil when it is found.

As for the design of crude oil lines, the problem is not entirely without precedent in Canada since small oil lines (both crude and products) have been installed in the North for many years. The Canol line was laid on the surface and carried Norman Well's crude in a 4" line 660 miles to Whitehorse. The Skagway-Whitehorse, 110 mile,4" products line was built in 1942 and is still in service. There is also a 10" military fuel supply pipeline from Haines to Fairbanks. As an example of the variety of background, a 48" water line was laid near Dawson City in the days of the gold rush. It is still relatively intact.

None of these lines, however, matches the modern large diameter, high strength pipeline contemplated for moving major crude reserves out of the Arctic.

What are the design problems? I believe they involve:

VUGRAPH 1: Communications

Access

Housing

Foundations

Right-of-ways

Welding and Metallurgy

Corrosion

Pipe stresses

Temperature

Some of these are already well in hand and do not require further research.

Communications

There is already a network of modern communication in the Arctic which will need to be expanded and perhaps updated to handle Industry needs.

Access

Access is one of the major economic factors in the Arctic. Costs and methods vary greatly with the season and planning is of utmost importance. Nevertheless, we know how to move large tonnages, and we know that if we move at the right time of the year the unit increment over similar movement--say in northern Alberta is not great. It might interest you to know that a pipeline projected from Haines to Fort McPherson (about 660 miles) would paral-

lel an existing railway or all-weather road for the southern 480 miles.

Housing

Housing has been the subject of N.R C. research. It is also a part of Imperial's experience. It is costly but otherwise is not an area of great concern. I believe, however, we should be prepared to try new ideas, not so much from an engineering standpoint as from an aesthetic or social standpoint. This will be a major factor in being able to keep competent employees on the job in the Arctic.

Foundations

Foundations are a problem on permafrost but methods are available to allow the design of permanent structures on permafrost and we should not need to do further research on this subject.

This leaves us to consider the right-of-way, welding and metallurgy, corrosion, temperature, and pipe stresses, all related directly to the pipeline.

Right-of-Ways

The pictures Gerry showed us of a seismic line well illustrate the problem of a right-of-way across the tundra. At first this seemed to me to be a little concern, in fact, it appeared feasible to leave the pipe on the surface and mound over it with moss. However, the continuation of exploration activities and probably more importantly, the pressure of wildlife and conservationist groups will almost certainly force us to bury the pipeline and leave a clear right-of-way. Moreover, the right-of-way must be left undisturbed, or be reinsulated in such a way that thawing and erosion will not undermine the pipe.

Corrosion

Corrosion will be almost nil in the Arctic. We have well-documented experience on this. The problem, however, is, can we safely lay a bare line in permafrost. If we could, there would be a saving of several millions of dollars on coatings.

We need enough data to back up the fellow with guts enough to decide not to coat a 500 MM line. Here as in so many areas of the Ar[illegible] a lack of knowledge may cause just to put i[illegible] a safety factor and we can safety factor ours[illegible] out of busin[illegible]

Welding and Metallurgy

Experience in northern Alberta under winter conditions leads us to believe that we can handle these factors under Arctic conditions. However, both Imperial and Humble pipeline engineers are working on this aspect now and will report on it in 1967 with particular emphasis on welding of the newer high-strength steels.

Pipe Stresses and Temperature

Pipe stresses and temperature will be considered together as these are both areas of research in which producing has a part. We must of course determine at what temperature the pipeline will operate over the year and how this is affected by depth of burial and other factors. The following figures illustrate some of the available data.

Vu-graph 2 - Shallow soil temperature data is available from several sites in Canada.

Churchill	Kendall Island
Baker Lake	Inuvik
Resolute	Aishihik
Yellowknife	Haines Junction

Vu-graph 3 - Resolute.

Soil temperature data for the high Arctic. Note that the 8" and 18" depth soil temperatures vary from just above feezing to $-32^{o}F$ and $-25^{o}F$, respectively. Even with 5 feet of burial, temperatures are very cold and the temperature swings from summer to winter are about $60^{o}F$.

Vu-graph 4 - Inuvik.

There is a high variability of surface temperatures but a relatively stable temperature with 3 feet of burial. Seasonal variation is only 10 to 15°F. This is attributed to the organic cover present.

Vu-graph 5 - Aishihik.

The much higher soil temperatures are comparable with those in Alberta. There would be no temperature problems in a buried pipeline in this part of the Yukon.

Shallow thermistor strings were installed this fall at Norman Wells, Inuvik, and Arctic Red River. These stations are under various types of cover and in various soils. With thermistors set every foot to a depth of 10 feet we expect to get more detailed soil temperatures over the next 2 or 3 years. This data will give us a good basis for predicting pipeline operating temperatures over the full length of the proposed line. Based on our limited data I would recommend this

Vu-graph 6 - Pipeline Ditch Cross Section.

If this technique were used, one would expect the permafrost to rise around the pipe and provide a stable environment immediately around the pipeline.

A problem which we are concerned with now has to do with the pipe stresses generated as the pipeline passes from frozen to thawed to frozen ground. It is known that there is no permafrost under deeper lakes and rivers and any of you who have flown over the North will realize that any major line will have to cross many, many lakes and rivers. It is not known what pipe stresses will occur under freeze-thaw condi-

tions near the edges of these lakes and rivers. We are not even sure how to go about finding out, short of laying a section of pipeline and instrumenting it to measure strain. It is planned that this problem be examined next year.

We welcome your ideas and comments.

R. A. HEMSTOCK

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We welcome your ideas and comments.

R. A. HEMSTOCK

PIPELINE RESEARCH PROJECT #483

MEETING OCTOBER 31 - 9:00 A.M.

AGENDA

(1) (a) Rheology of Crude Oils at Low Temperatures - B. C. McCartney

(b) Future plans.

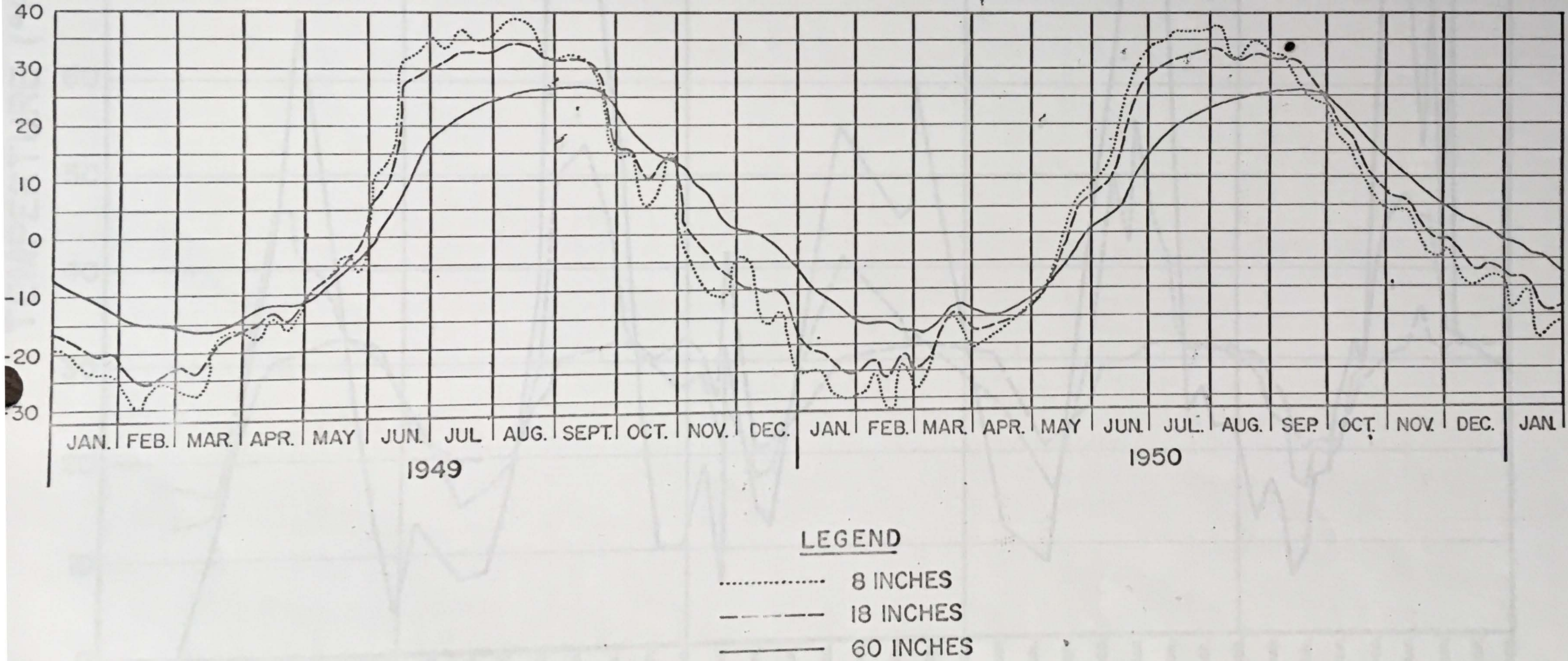
2) Probable Oil & Pipe Temperatures - - A. Hemstock

3) Pipeline Stresses -- General Discussion - see Letter Oct. 18

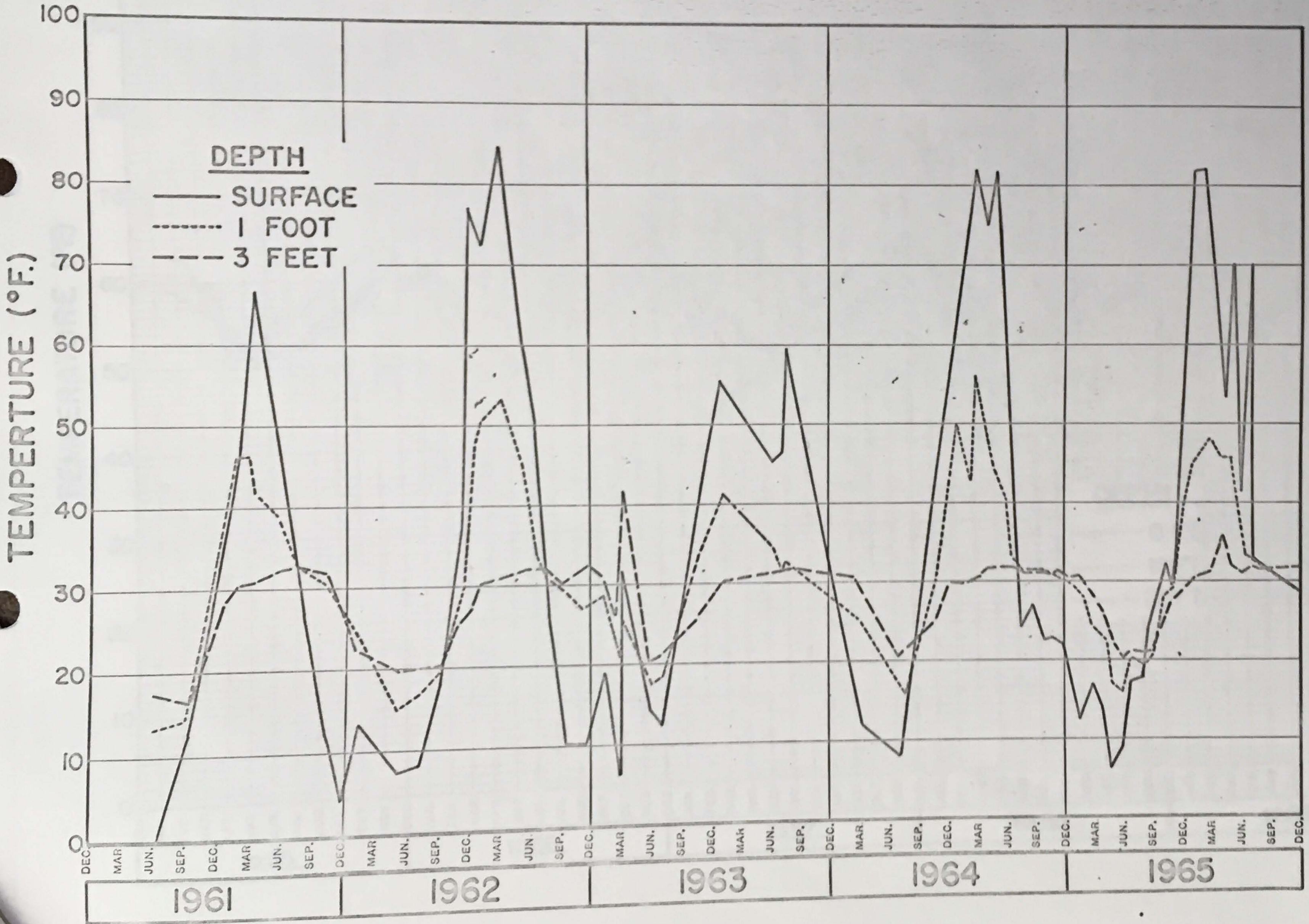
4) Outline research project (1967) to define stress levels in Arctic pipelines.

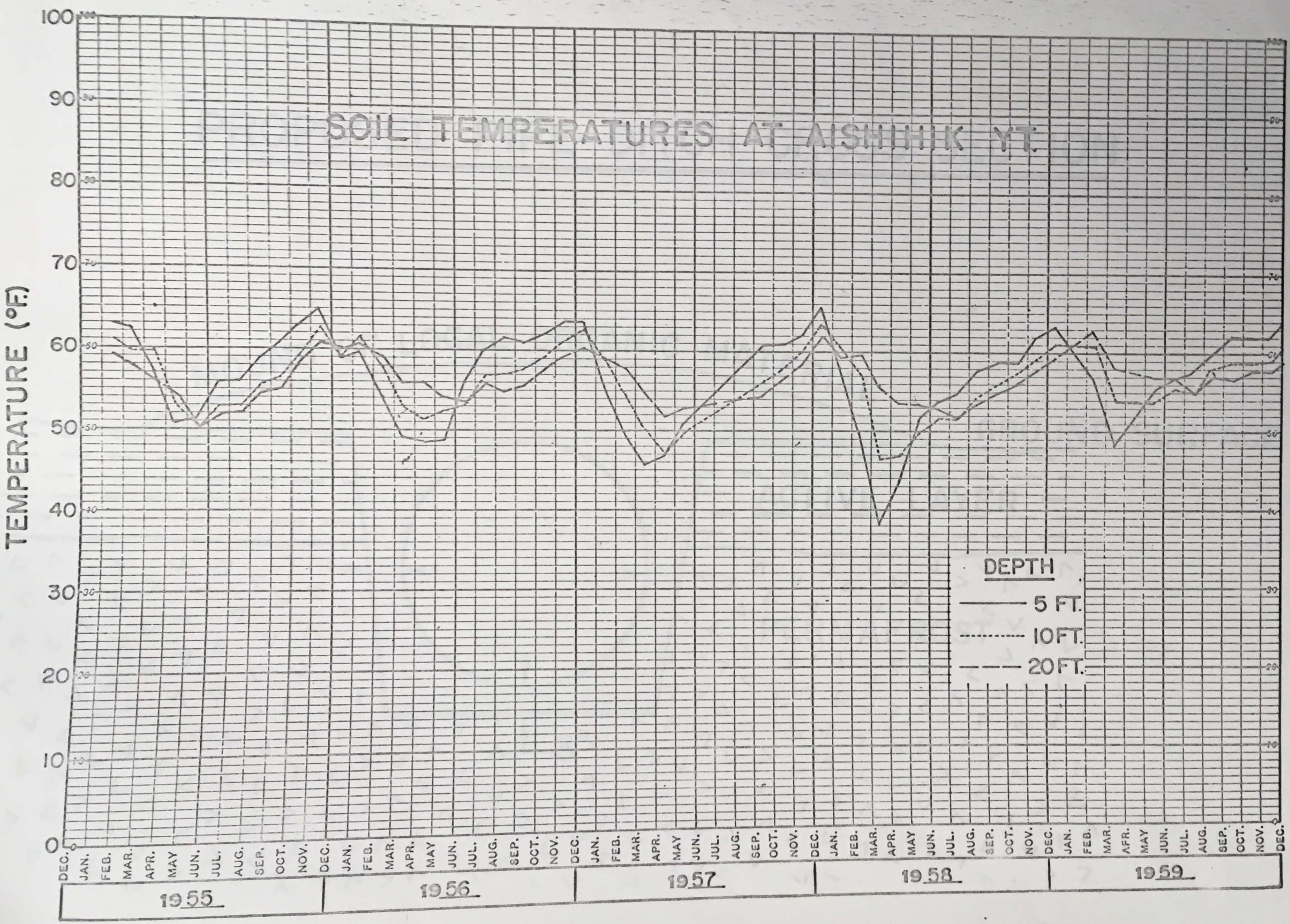
SOIL TEMPERATURES AT RESOLUTE

1949 - 1950

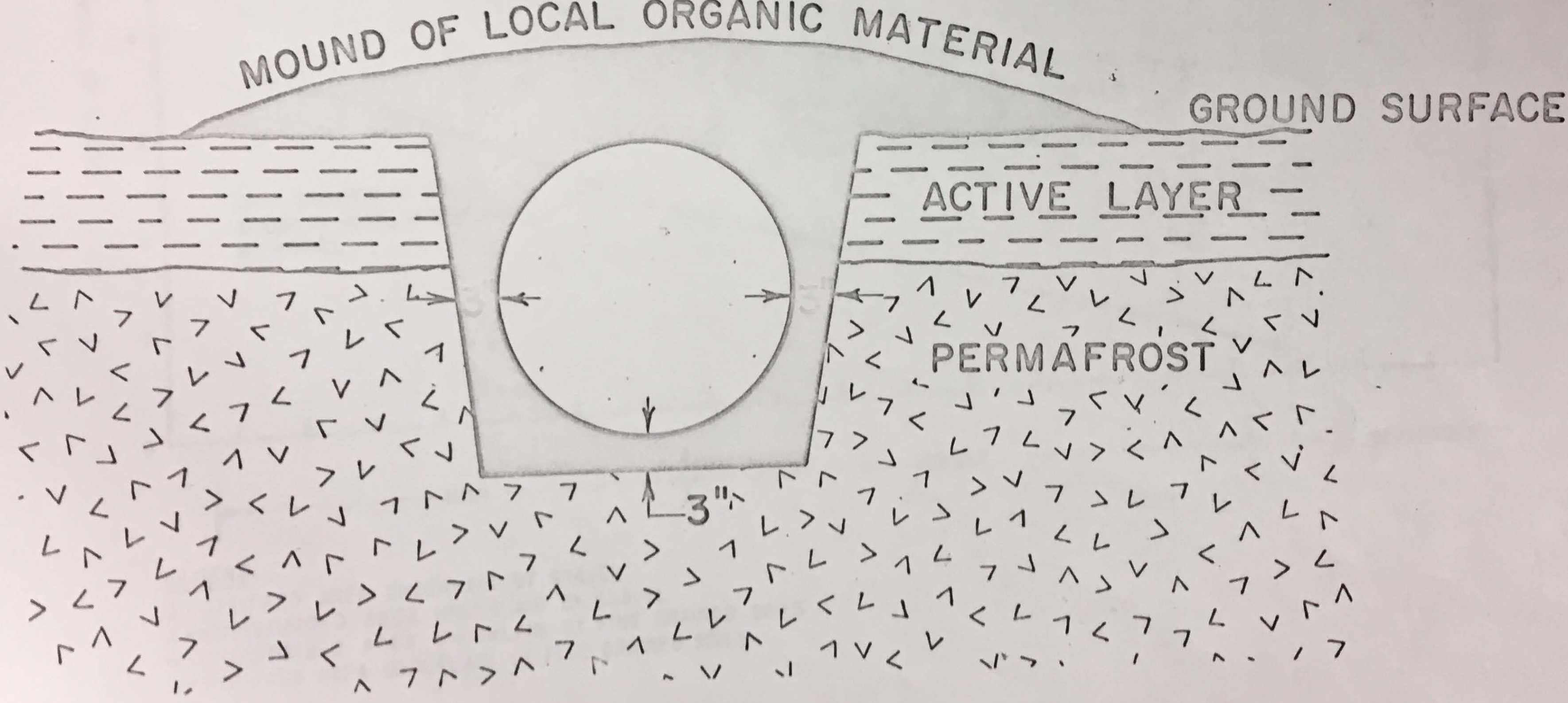


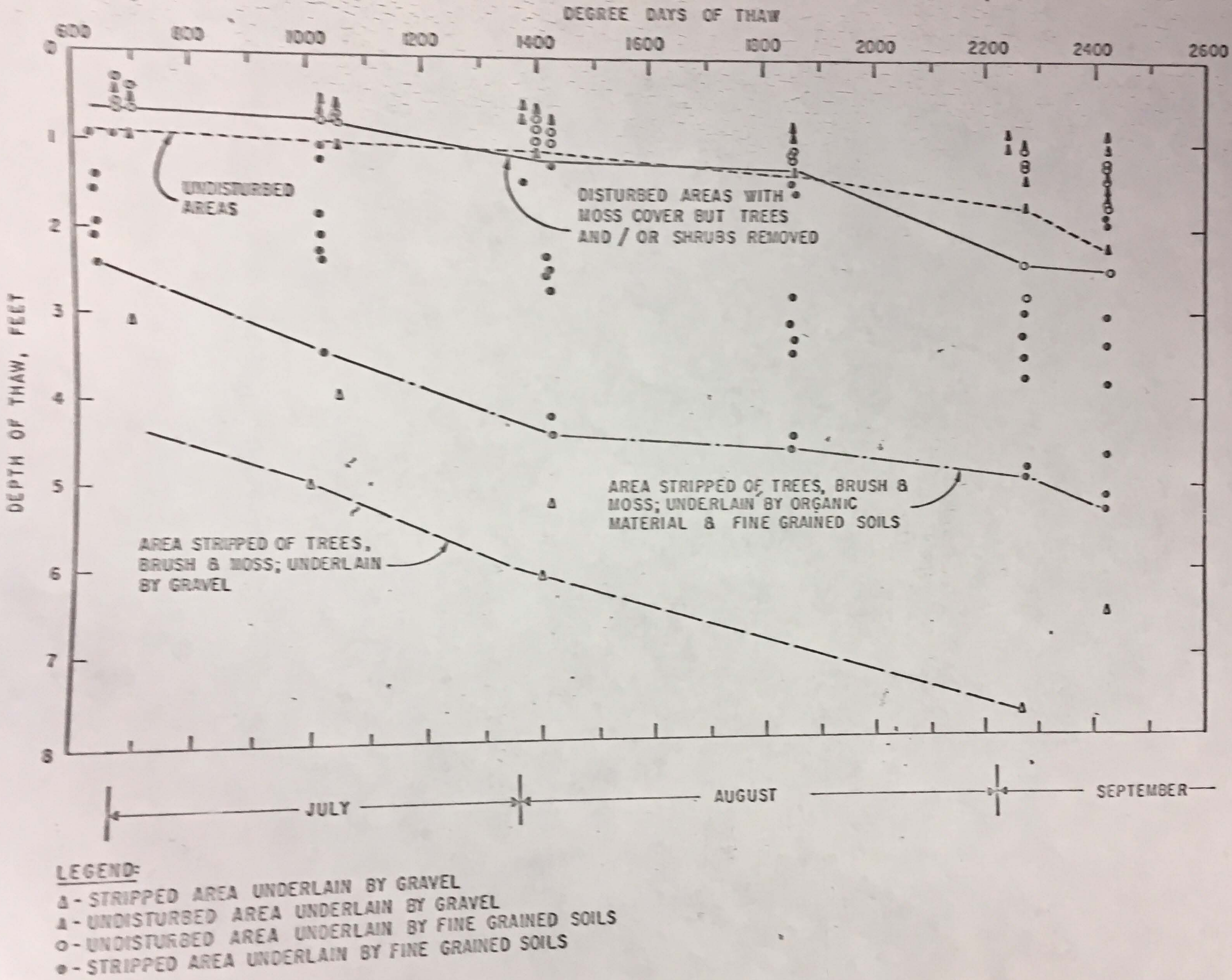
SOIL TEMPERATURES - INUVIK N.W.T.
HOSPITAL THAW SITE (NRC)




SOIL TEMPERATURES AT AISHIHIK Y.T.
TEMPERATURE (°F)
100
90
80
70
60
50
40
30
20
10
0
DEPTH
5 FT.
10 FT.
20 FT.
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1955
1956
1957
1958
1959

PROPOSED PIPE-DITCH CROSS SECTION





EXTREME LIMITS OF THE DEPTH OF THAW AT INUVIK, 1957

PL 186 (2-64)

HUMBLE PIPE LINE COMPANY
P. O. BOX 2220
HOUSTON, TEXAS 77001

November 1, 1966

7.8.3 Arctic Pipeline Study
PLR 482

Mr. W. J. Keys
Imperial Oil Limited
111 St. Clair Avenue West
Toronto, Ontario
Canada

Dear John:

While visiting the Arctic Field Station near Fairbanks, Alaska, we learned that a special test was conducted on pipe and soil temperature as part of the Navy Petroleum 4 Project. We sent an inquiry on this test program to the Cold Regions Research and Engineering Laboratory at Hanover, New Hampshire. They have replied, giving some information on the work done at the Arctic Field Station and mentioning other data that they have on a similar test at Gulkana, Alaska.

The data received covers a period of one year and appears to be representative of the average temperature conditions for that area. They also sent a rough draft of the Ground Temperature Observations for Tanana, Alaska, similar to the formal reports of other locations mentioned in our letter of September 28, 1966. We are sending a copy of this Tanana temperature data and a copy of the pipe and soil temperature test data to Alex Hemstock. Please advise if it is desirable to have the pipe and soil temperature test data for the Gulkana location. The CRREL office can supply it on a specific request.

The sketch of the pipe and soil test layout was not included in the data received from CRREL. However, we have reproduced it from memory of a sketch seen at the Arctic Field Station.

Yours very truly,

F. A. Therrell

F. A. Therrell

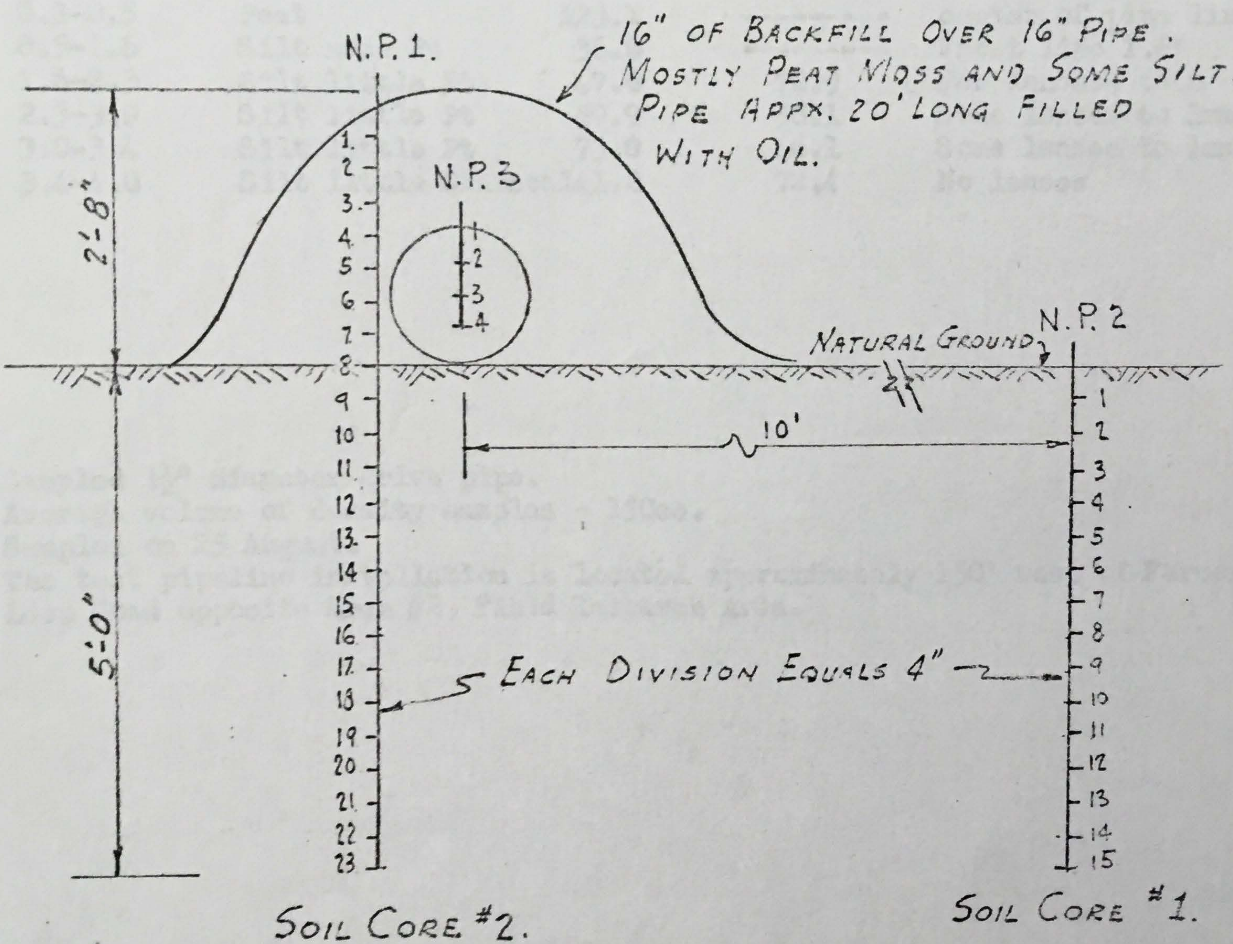
FAT:tms
Attachments

cc: Mr. R. A. Hemstock w/attachments
Central Records

TYPICAL LAYOUT OF TEMPERATURE TEST.

ON BACKFILL, SOIL AND LINE FILL.

NAVY PETROLEUM 4 PROJECT (1950-1954)



FAT 10-31-66

SOILS INFORMATION
NAVY TEST PIPELINE INSTALLATION
GROUND TEMPERATURE HOLES 1 AND 2
FIELD RESEARCH AREA - Fairbanks, Alaska
USA CRREL

Sample Number	Depth Feet	Classification	Moisture Content %	Density lbs/cu ft	Remarks
Pipe-1-1	0-0.3	Live Moss	155.2	----------	Located 10' west of
Pipe-1-2	0.3-0.6	Peat	130.0	----------	center of test pipe line
Pipe-1-3	0.6-1.1	Silt much Pt	66.7	----------	
Pipe-1-4	1.1-1.5	Silt some Pt	40.2	----------	Frost line at 1.5'
Pipe-1-5	1.5-2.1	Silt little Pt	66.5	54.2	Some thin lenses
Pipe-1-6	2.1-2.7	Silt little Pt	64.9	60.1	Some lenses to 1mm
Pipe-1-7	2.7-3.3	Silt no Pt	60.2	62.2	Many thin lenses
Pipe-1-8	3.3-4.0	Silt some Charcoal	41.3	75.0	No lenses
Pipe-2-1	0-0.3	Live Moss	103.6	----------	Located adjacent to
Pipe-2-2	0.3-0.5	Peat	125.1	----------	center of pipe line
Pipe-2-3	0.5-1.6	Silt some Pt	36.6	----------	Frost line 1.6'
Pipe-2-4	1.6-2.3	Silt little Pt	47.6	72.9	Few lenses, thin
Pipe-2-5	2.3-3.0	Silt little Pt	59.9	58.1	Some lenses to 1mm
Pipe-2-6	3.0-3.4	Silt little Pt	73.0	46.1	Some lenses to 1mm
Pipe-2-7	3.4-4.0	Silt little Charcoal	41.2	72.4	No lenses

Notes:

1. Sampled $1\frac{1}{2}$" diameter drive pipe.
2. Average volume of density samples - 150cc.
3. Sampled on 25 August.
4. The test pipeline installation is located approximately 150' west of Farmers Loop Road opposite Area #2, Field Research Area.

Incl. 1

PF FORM 17
13 SEP 51

Incl 1

PF FORM 17
13 SEP 51

PIPELINE TEST STATION
TEMPERATURE RECORD

DATE 17 NOV. 51

STATION FAIRBANKS.

OBSERVATION NO. 10

DAYS ELAPSED SINCE PREVIOUS OBSERVATION 7 DAYS

DEPTH OF SNOW 6"

INSTRUMENT NO. 3.

TEMPERATURE OF ICE BATH = 0°C ✓

OBSERVER Loff N'S.

TIME
START 1140
FINISH 1210

AIR TEMPERATURE (Ambient) -13.0 °C

SWITCH NO. 1 (Thermocouples 1 thru 23 in moss fill and ground adjacent to pipe)

NR1.

START 1140

Switch Point No.	Depth in Moss Fill	Temperature °C
23	5'-0"	-0.3
1	0'-4"	-11.0
2	0'-8"	-10.8
3	1'-0"	-10.6
4	1'-4"	-10.0
5	1'-8"	-9.6
6	2'-0"	-2.5
7	2'-4"	-8.6
8	2'-8"	-7.0
	Depth in Ground	
9	0'-4"	-2.8
10	0'-8"	-1.5
11	1'-0"	-0.6
12	1'-4"	0.0
13	1'-8"	0.0
14	2'-0"	0.0
15	2'-4"	0.0
16	2'-8"	0.0
17	3'-0"	0.0
18	3'-4"	0.0
19	3'-8"	0.0
20	4'-0"	0.0
21	4'-4"	0.0
22	4'-8"	-0.1
23	5'-0"	-0.2
		-0.5

FINISH 1150

SWITCH NO. 2 (Thermocouples 1 thru 15 in natural ground) (Thermocouples 1 thru 4 in pipe)

NR2.

START 1150

Switch Point No.	Depth in Ground	Temperature °C
15	5'-0"	✓
1	0'-4"	-10.1
2	0'-8"	-6.8
3	1'-0"	-3.0
4	1'-4"	-1.3
5	1'-8"	-0.5
6	2'-0"	-0.1
7	2'-4"	0.0
8	2'-8"	0.0
9	3'-0"	0.0
10	3'-4"	0.0
11	3'-8"	0.0
12	4'-0"	0.0
13	4'-4"	0.0
14	4'-8"	0.0
15	5'-0"	✓ 0.0

FINISH 1200

NR.3

START 1200

Switch Point No.	Location in Pipe	Temperature °C
4	4" BELOW CENTER	-3.7
1	8" ABOVE CENTER	[illegible]
2	4" ABOVE CENTER	-3.5
3	CENTER POINT	-3.3
4	4" BELOW CENTER	-3.7

FINISH 1205

REMARKS ✓ OUT OF SERVICE

Potentiometer-Used, Tested-Weekly For Accuracy

PF FORM 17
13 SEP 51

PIPELINE TEST STATION
TEMPERATURE RECORD

DATE 15 Dec. 51.
STATION FAIRBANKS.
OBSERVATION NO. 14
DAYS ELAPSED SINCE PREVIOUS OBSERVATION 7
DEPTH OF SNOW 8"
INSTRUMENT NO. 3

TEMPERATURE OF ICE BATH = 0°C ✓

OBSERVER [illegible]

TIME
START 1150
FINISH 1220

AIR TEMPERATURE (Ambient) -20.2 °C

SWITCH NO. 1 (Thermocouples 1 thru 23 in moss fill and ground adjacent to pipe)

NR. 1.

Switch Point No.	Depth in Moss Fill	Temperature °C
23	5'-0"	-0.3
1	0'-4"	-13.0
2	0'-8"	-13.3
3	1'-0"	-13.5
4	1'-4"	-12.6
5	1'-8"	-11.2
6	2'-0"	-9.4
7	2'-4"	-7.7
8	2'-8"	-6.3
	Depth in Ground	
9	0'-4"	-5.1
10	0'-8"	-3.3
11	1'-0"	-2.7
12	1'-4"	-1.1
13	1'-8"	-0.3
14	2'-0"	-0.1
15	2'-4"	0.0
16	2'-8"	0.0
17	3'-0"	0.0
18	3'-4"	0.0
19	3'-8"	-0.2
20	4'-0"	-0.2
21	4'-4"	-0.3
22	4'-8"	-0.3
23	5'-0"	-0.3

START 1150
FINISH

SWITCH NO. 2 (Thermocouples 1 thru 15 in natural ground) (Thermocouples 1 thru 4 in pipe)

NR 2

Switch Point No.	Depth in Ground	Temperature °C
15	5'-0"	X
1	0'-4"	X
2	0'-8"	-9.3
3	1'-0"	-3.7
4	1'-4"	-1.8
5	1'-8"	-1.2
6	2'-0"	-0.7
7	2'-4"	-0.2
8	2'-8"	-0.1
9	3'-0"	-0.1
10	3'-4"	0.0
11	3'-8"	0.0
12	4'-0"	-0.1
13	4'-4"	-0.1
14	4'-8"	-0.2
15	5'-0"	X
NR 3.	Location in Pipe	
4	4" BELOW CENTER	-5.0
1	8" ABOVE CENTER	-5.8
2	4" ABOVE CENTER	-5.2
3	CENTER POINT	-5.1
4	4" BELOW CENTER	-5.0

START 1205
FINISH
START 1215
FINISH

REMARKS X OUT OF Service

ARMY [illegible]

PF FORM 17
13 SEP 51

PIPELINE TEST STATION
TEMPERATURE RECORD

DATE 12 JANY. 52 OBSERVATION NO. 18 DEPTH OF SNOW 28"

STATION FAIRBANKS. DAYS ELAPSED SINCE PREVIOUS OBSERVATION 7 INSTRUMENT NO. 3

TEMPERATURE OF ICE BATH = 0°C ✓

OBSERVER ~~M.S.~~

TIME START 1230 FINISH 1300

AIR TEMPERATURE (Ambient) −30.0 °C

SWITCH NO. 1 *(Thermocouples 1 thru 23 in moss fill and ground adjacent to pipe)*

NR1.

Switch Point No.	Depth in Moss Fill	Temperature °C	
23	5'-0"	−2.3	START 1230
1	0'-4"	−19.5	
2	0'-8"	−19.6	
3	1'-0"	−19.0	
4	1'-4"	−18.0	
5	1'-8"	−16.6	
6	2'-0"	−13.5	
7	2'-4"	−10.0	
8	2'-8"	−8.0	
	Depth in Ground		
9	0'-4"	−6.5	
10	0'-8"	−5.5	
11	1'-0"	−3.0	
12	1'-4"	−2.0	
13	1'-8"	−1.0	
14	2'-0"	−0.5	
15	2'-4"	−0.3	
16	2'-8"	−0.1	
17	3'-0"	−0.1	
18	3'-4"	−0.1	
19	3'-8"	−0.1	
20	4'-0"	−0.2	
21	4'-4"	−0.2	
22	4'-8"	−0.2	
23	5'-0"	−0.2	FINISH

SWITCH NO. 2 *(Thermocouples 1 thru 15 in natural ground)*
(Thermocouples 1 thru 4 in pipe)

NR2.

Switch Point No.	Depth in Ground	Temperature °C	
15	5'-0"	X	START 1240
1	0'-4"	X	
2	0'-8"	−6.0	
3	1'-0"	−3.0	
4	1'-4"	−2.0	
5	1'-8"	−1.5	
6	2'-0"	−1.0	
7	2'-4"	−0.5	
8	2'-8"	−0.2	
9	3'-0"	−0.2	
10	3'-4"	−0.2	
11	3'-8"	−0.2	
12	4'-0"	−0.2	
13	4'-4"	−0.7	
14	4'-8"	−0.7	
15	5'-0"	X	FINISH
NR3	Location in Pipe		
4	4" BELOW CENTER	−5.5	START 1250
1	8" ABOVE CENTER	−6.5	
2	4" ABOVE CENTER	−5.5	
3	CENTER POINT	−5.5	
4	4" BELOW CENTER	−5.5	FINISH

REMARKS X OUT

ARMY SL AGPC

PF FORM 17
13 SEP 51

PIPELINE TEST STATION
TEMPERATURE RECORD

DATE 16 Feb'y. 52 OBSERVATION NO. 23 DEPTH OF SNOW 28

STATION FAIRBANKS, DAYS ELAPSED SINCE PREVIOUS OBSERVATION 7 INSTRUMENT NO. 3

TEMPERATURE OF ICE BATH = 0°C ✓

OBSERVER [illegible] NIS,

TIME
START 1115
FINISH 1145

AIR TEMPERATURE *(Ambient)* -20.0 °C

SWITCH NO. 1 *(Thermocouples 1 thru 23 in moss fill and ground adjacent to pipe)*

NP.1

Switch Point No.	Depth in Moss Fill	Temperature °C
23	5'-0"	-0.9
1	0'-4"	-10.8
2	0'-8"	-10.6
3	1'-0"	-10.4
4	1'-4"	-10.0
5	1'-8"	-8.8
6	2'-0"	-7.7
7	2'-4"	-6.6
8	2'-8"	-5.5
	Depth in Ground	
9	0'-4"	-4.7
10	0'-8"	-4.0
11	1'-0"	-3.6
12	1'-4"	-3.1
13	1'-8"	-2.9
14	2'-0"	-2.7
15	2'-4"	-2.3
16	2'-8"	-2.0
17	3'-0"	-1.7
18	3'-4"	-1.4
19	3'-8"	-1.3
20	4'-0"	-1.2
21	4'-4"	-1.1
22	4'-8"	-1.0
23	5'-0"	-0.9

START 1115

FINISH

SWITCH NO. 2 *(Thermocouples 1 thru 15 in natural ground)* *(Thermocouples 1 thru 4 in pipe)*

NP2

Switch Point No.	Depth in Ground	Temperature °C
15	5'-0"	X
1	0'-4"	X
2	0'-8"	-4.7
3	1'-0"	-2.6
4	1'-4"	-1.8
5	1'-8"	-1.7
6	2'-0"	-1.6
7	2'-4"	-0.9
8	2'-8"	-0.8
9	3'-0"	-0.7
10	3'-4"	-0.2
11	3'-8"	-0.2
12	4'-0"	-0.1
13	4'-4"	-0.2
14	4'-8"	~~[illegible]~~ -0.3
15	5'-0"	X
NP3	Location in Pipe	
4	4" BELOW CENTER	-4.0
1	8" ABOVE CENTER	-4.4
2	4" ABOVE CENTER	-4.0
3	CENTER POINT	-4.0
4	4" BELOW CENTER	-4.0

START 1125

FINISH

START 1135

FINISH

REMARKS XOUT

ARMY AGPC

PF FORM 17
13 SEP 51

PIPELINE TEST STATION
TEMPERATURE RECORD

DATE 15 MARCH 52 ✓ OBSERVATION NO. 27. DEPTH OF SNOW 24"

STATION FAIRBANKS.

DAYS ELAPSED SINCE PREVIOUS OBSERVATION 7 INSTRUMENT NO. 3

TEMPERATURE OF ICE BATH = 0°C ✓

OBSERVER [illegible]

TIME
START 11.50
FINISH 13.50

AIR TEMPERATURE (*Ambient*) −6.0 °C

SWITCH NO. 1 (*Thermocouples 1 thru 23 in moss fill and ground adjacent to pipe*)

N.P. 1.

Switch Point No.	Depth in Moss Fill	Temperature °C
23	5'-0"	−1.8
1	0'-4"	−8.8
2	0'-8"	−8.8
3	1'-0"	−9.5
4	1'-4"	−9.0
5	1'-8"	−8.7
6	2'-0"	−8.7
7	2'-4"	−7.7
8	2'-8"	−6.0
	Depth in Ground	
9	0'-4"	−5.3
10	0'-8"	−4.7
11	1'-0"	−4.4
12	1'-4"	−4.0
13	1'-8"	−3.8
14	2'-0"	−3.5
15	2'-4"	−3.2
16	2'-8"	−2.6
17	3'-0"	−2.6
18	3'-4"	−2.3
19	3'-8"	−2.1
20	4'-0"	−2.1
21	4'-4"	−2.0
22	4'-8"	−2.0
23	5'-0"	−1.8

START 1150

FINISH

SWITCH NO. 2 (*Thermocouples 1 thru 15 in natural ground*)
(*Thermocouples 1 thru 4 in pipe*)

N.P. 2.

Switch Point No.	Depth in Ground	Temperature °C
15	5'-0" X	
1	0'-4" X	
2	0'-8"	−5.0
3	1'-0"	−3.3
4	1'-4"	−2.7
5	1'-8"	−2.6
6	2'-0"	−2.5
7	2'-4"	−2.2
8	2'-8"	−2.0
9	3'-0"	−1.8
10	3'-4"	−1.6
11	3'-8"	−1.1
12	4'-0"	−1.1
13	4'-4"	−0.8
14	4'-8"	−0.8
15	5'-0" X	
N.P. 3.	**Location In Pipe**	
4	4" BELOW CENTER	−1.2
1	8" ABOVE CENTER	−1.5
2	4" ABOVE CENTER	−1.1
3	CENTER POINT	−1.3
4	4" BELOW CENTER	−1.2

START 1210

FINISH ~~[illegible]~~

START 1225

FINISH

REMARKS X OUT

ARMY Bd. AGPC [illegible]

October 25, 1966

File: 9.666 E.

Mr. G. Hughes
Humble Pipe Line Company,
P.O. Box 2200,
Houston, Texas.

<u>Attention Mr. R.L. Bullock</u>

Dear Sir:

We have attached a copy of the proposed agenda for the meeting to be held in Calgary on October 31, 1966. It is understood Mr. Bill Walton will be attending.

As you will note from the attached agenda, it is our plan to develop a test programme for stress analysis on pipe lines in Arctic areas.

Yours very truly,

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.

Encl.

andard Oil Company

ORPORATED IN New Jersey

ROCKEFELLER PLAZA, NEW YORK, N.Y. 10020

Transportation Coordin

C. COOK
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October 21, 196

I'll key this article
in the Arctic Research
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John

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the Calgary Inn

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HCC:ms
Att:

P/L DIVISION			
FILE No. 9.66 E			
OCT 24 1966			
	NOTE	ACT	INITIAL
KRS			
CC	✓		CC
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RAP			
LDA			
BMB			
CJB			
RDC			
CVH			
WJK	✓		WJK
DATE ANS'D 3006			

HCC

Yours very truly,

H. C. Cook

HCC:ms

Mr. R. A. Hemstock

Standard Oil Company

INCORPORATED IN New Jersey

30 ROCKEFELLER PLAZA, NEW YORK, N.Y. 10020

Transportation Coordination Department

H. C. COOK
Manager, Pipe Line Research

October 21, 1966

Mr. W. J. Keys
Imperial Oil Limited
Pipe Line Division
111 St. Clair Avenue, West
Toronto, Ontario, Canada

Arctic Pipeline Stress
Measurement Mtg. - 10/31/66

Dear John:

Enclosed is a copy of the article that appeared in Pipeline Engineer in 1956. It is entitled "How to Use Bonded-Wire Strain Gages" and summarizes the information which was presented at the Seminar held at Battelle in 1955. Mr. Gene McClure of Battelle has indicated that no other material has been released subsequent to this article and the information is still valid.

I am pleased to see that Billy Walton from Humble Pipe Line Company will be at the meeting in Calgary on the 31st. He is well qualified and will be a great help to the Arctic project with the Strain Gage work.

Since this project is of extreme interest to the PLR Program and Transcor, I am also planning to attend this meeting and will arrive in Calgary on Sunday evening, October 30. By copy of this letter, I would appreciate it if Alex Hemstock would make a reservation for me at the Calgary Inn for Sunday and Monday nites.

Yours very truly

H. C. Cook

H. C. Cook

HCC:ms

cc: Mr. R. A. Hemstock

P/L DIVISION
FILE No. 9.666-E
OCT 24 1966

	NOTE	ACT	INITIAL
KRS			
CC	✓		
DMK			
RAP			
LDA			
BMB			
CJB			
ROC			
CVH			
WJK	✓		WJK
DATE ANSD	3009.		

Note: Attachment kept in Arctic Research File. Also copy made & put in file 7.3.1 with PLR Report #F-33
WJK.

October 20, 1966.

<u>Re: Russian Papers - Arctic Pipe Lines</u>
File: 9.666E

Mr. R.H. Teskey, Manager,
Imperial Oil Limited,
Western Region Producing Department,
339 50th Avenue S.E.,
Calgary, Alberta.

<u>Attention Mr. R.A. Hemstock</u>

Dear Sir:

It is noted in correspondence between Mr. G.H. Johnston of N.R.C., Ottawa and Mr. W.W. Boucher that you had translations made about two years ago of the three Russian papers referred to below. These are listed in our bibliography but apparently no copies are on hand here. If convenient, please have a copy of each made so they may be picked up at the time of our forthcoming meeting.

These papers are as follows:

1. Baranovskii, A.N. - The Tazovskoe - Norilsk Gas Line - The World's Northermost Gas Magistral, Stroitel'stovo Truboprovodov #8, August 1964.

2. Anenkov, N.J. and M.P. Anuchkin - Pipes for Gas Lines in the Far North, Stroitel'stovo Trubopovodov, #9, September, 1964.

3. Semenov, L.P., G.M. Feldman and Y.L. Shur - On the Thermal Conditions of Oil Pipelines, Mat. k osn. uch. o merz. zon zem. kory No. 7, pp. 119-131, 1961.

We have copies of fo r more recent Russian papers by Semenov and Porkhaev which, it is understood, you have arranged to have translated.

Yours very truly,
K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.

HUMBLE PIPE LINE COMPANY
P. O. Box 2220
Houston, Texas 77001

TECHNICAL SERVICES DEPARTMENT
GEORGE G. HUGHES, JR.
MANAGER
A.V. CARDIN
ENGINEERING COORDINATOR
J. E. BARBEE
COMMUNICATIONS COORDINATOR
ROBERT L. BULLOCK
RESEARCH COORDINATOR

October 19, 1966

7.8.3 Arctic Project #482

Mr. K. R. Shipley
Imperial Oil Limited
111 St. Clair Avenue West
Toronto, Ontario
Canada

Attention: Mr. C. Carlisle ?

Dear Mr. Shipley:

Thanks for the invitation to attend the Pipeline Research Meeting on 1967 Arctic Projects scheduled for October 31, 1966 in Calgary. We have selected Mr. B. G. Walton to represent Humble Pipe Line Company. As you recall, Billy Walton was the leader on the PLR project entitled, "Pipeline Stress Above and Below Ground;" and through this project and our participation in the American Gas Association Branch Connection Research Project, attended the AGA-Battelle school on strain gauges.

Mr. Walton will be arriving in Calgary the evening of October 30, Western Flight 54 at 9:17 p.m. and is making reservations for the Calgary Inn.

We know that you are going to have an interesting meeting and we will be looking forward to Mr. Walton's reports.

Yours very truly,

Robt L. Bullock

RLB:tms

cc: Messrs: R. A Hemstock
H. C. Cook
B. G. Walton
Central Records

October 18, 1966.

Re: Arctic Pipe Line Project #483

File 9,666E

Mr. R.H. Teskey, Manager,
Imperial Oil Limited,
Western Region Producing Department
339 50th Avenue South East
Calgary, Alberta

Attention: Mr. R.A. Hemstock

Dear Sir:

In conjunction with the presentation on the oil fluid properties at the meeting to be held the end of October in your offices, a review of the stress analysis phase is also planned. We have attached a copy of the proposed agenda in which we have endeavoured to cover those aspects that we feel require consideration.

We would like you to review this and also discuss it within your own group with regard to the technical and physical aspects of testing. Since it is planned that this work will be a co-operative test programme with both our groups participating, it is hoped that we may be able to formulate a test programme at our meeting.

If you feel that specific information is required on any particular aspect prior to the meeting we would be pleased to hear from you.

Yours very truly,

K.R. Shipley,

By:______________________
W.J. Keys.

WJK/EG.

cc. Mr. E.W. Christian.

October 18, 1966.

Re: Arctic Pipe Line Project #483

File: 9.666E

Mr. H.C. Cook,
Transportation Co-ordination Department
Standard Oil Co. (NJ)
30 Rockefeller Plaza
New York N.Y. 10020.

Dear Sir:

We have attached hereto a copy of the agenda for a proposed meeting at Calgary with Production Research people at the end of October. At that time we will be reviewing the various aspects of the stress analysis work on this Project with a view to arriving at a firm plan of the programme to follow on this phase. We felt you would be interested in the areas we propose to cover at that time.

Mr. R.A.H. Hemstock will also be making a review of their work on the oil fluid properties and methods of test and analysis. This is in conjunction with the work they are undertaking on this same project.

Yours very truly,

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.

October 18, 1966.

Re: Arctic Pipe Line Project #483

File: 9.666E

Mr. H.C. Cook,
Transportation Co-ordination Department
Standard Oil Co. (NJ)
30 Rockefeller Plaza
New York N.Y. 10020.

Dear Sir:

We have attached hereto a copy of the agenda for a proposed meeting at Calgary with Production Research people at the end of October. At that time we will be reviewing the various aspects of the stress analysis work on this Project with a view to arriving at a firm plan of the programme to follow on this phase. We felt you would be interested in the areas we propose to cover at that time.

Mr. R.A.H. Hemstock will also be making a review of their work on the oil fluid properties and methods of test and analysis. This is in conjunction with the work they are undertaking on this same project.

Yours very truly,

K.R. Shipley,

By:________________________
W.J. Keys.

WJK/EG.